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FINAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT ZONE H VOLUME 1 SECTIONS 1 THROUGH 4 CNC CHARLESTON SC

7/5/1996

ENSAFE/ ALLEN AND HOSHALL

2

FINAL RCRA FACILITY INVESTIGATION REPORT FOR ZONE H NAVAL BASE CHARLESTON

VOLUME I
SECTIONS 1-4

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Prepared for:

Comprehensive Long-Term Environmental Action Navy (CLEAN)
Charleston Naval Shipyard
Charleston, South Carolina

Prepared by:

EnSafe/Allen & Hoshall
5720 Summer Trees Drive, Suite 8
Memphis, Tennessee 38134
(901)383-9115

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Table of Contents

List of Figures

List of Tables

List of Appendices

ABBREVIATIONS, ACRONYMS, AND SYMBOLS FOR NAVBASE ZONE H

The following abbreviations, acronyms, and units of measurement are used in this report.

AA	Atomic Absorption
ABF	Absorption Factor
AEC	Area of Ecological Concern
AL	Action Level
AOC	Area of Concern
AQTESOLV	Aquifer Test Solver
AST	Aboveground Storage Tank
ASTM	American Society for Testing and Materials
atm	Atmospheres
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
BAP	Benzo(a)pyrene
BDL	Below Detection Limit
BE	Barometric Efficiency
BEHP	Bis(2-ethylhexyl)phthalate
BEQ	BAP Equivalent
BEST	Building Economic Solutions Together
bgs	Below ground surface
BHC	Benzene hexachloride
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure Act of 1988 and Defense Base Closure and Realignment Act of 1990, collectively
BTEX	Benzene, toluene, ethylbenzene, and xylene
CAMP	Corrective Action Management Plan
CAMU	Corrective Action Management Unit
CDD	Chlorinated dibenzo-p-dioxin
CDF	Chlorinated dibenzofuran
CDI	Chronic Daily Intake
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Calibration Factor
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
cm/sec	Centimeters per second
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CNS	Central Nervous System
CNSY	Charleston Naval Shipyard

COC	Chemical of Concern
COPC	Chemical of Potential Concern
cPAH	Carcinogen Polynuclear Aromatic Hydrocarbon
CPSS	Chemical Present in Site Samples
CRAVE	Carcinogen Risk Assessment Verification Endeavor
CRDL	Contract Required Detection Limit
CSAP	Comprehensive Sampling and Analysis Plan
CSI	Confirmatory Sampling Investigation
CT	Central Tendency
DAF	Dilution Attenuation Factor
DCAA	2,4-Dichlorophenylacetic acid
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyl-trichloroethane
DNAPL	Dense Non-Aqueous Phase Liquid
DQO	Data Quality Objectives
DRO	Diesel Range Organics
DWEL	Drinking Water Equivalent Level
E/A&H	EnSafe/Allen & Hoshall
ECAO	Environmental Criteria and Assessment Office
ECPC	Ecological Chemical of Potential Concern
EMPC	Estimated Maximum Possible Concentration
EOD	Explosive Ordnance Disposal
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESA	Ecological Study Area
ESDSOPQAM	Environmental Services Division Standard Operating Procedures and Quality Assurance Manual
ESOD	Erythrocyte superoxide dismutase
FC	Fraction Contracted
FFI	Focused Field Investigation
FI	Fraction Ingested
FID	Flameionization detector
GC/MS	Gas Chromatography/Mass Spectrometry
gpm	Gallons per minute
GPS	Global Positioning System
GRO	Gasoline Range Organics
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HMW	High Molecular Weight
HQ	Hazard Quotient

HSWA	Hazardous and Solid Waste Amendments
HTTD	High-Temperature Thermal Desorption
ICM	Interim Corrective Measure
ICP	Inductively Coupled Plasma
ID	Inside Diameter
IDL	Instrument Detection Limit
ILCR	Incremental Lifetime Excess Cancer Risk
ILO	Indeterminate Lubricating Oil
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IS	Internal Standard
KPH	Kilometers per hour
LC_{50}	Lethal Concentration to 50 percent of test population
LCS	Laboratory Control Sample
LD_{50}	Lethal Dose to 50 percent of test population
LMW	Low Molecular Weight
LNAPL	Light Nonaqueous Phase Liquid
LQAC	Laboratory QA Coordinator
LTTD	Low-Temperature Thermal Desorption
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
meq/L	Milliequivalent per liter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
mg/m^3	Milligram per cubic meter
ml	Milliliter
mph	Miles per hour
msl	Mean sea level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NA	Not Applicable
NAD	North American Datum
NAVBASE	Naval Base Charleston
NBS	National Bureau of Standards
NCEA	National Center for Environmental Assessment
NCR	NEESA Contract Representative
ND	Not Detected
NEESA	Naval Energy and Environmental Support Activity
NFI	No Further Investigation
ng/kg	Nanogram per kilogram
NGVD	National Geodetic Vertical Datum
NIOSH	National Institute for Occupational Safety and Health
NL	Not Listed
NOAEL	No Observed Adverse Effect Level

NPDES	National Pollutant Discharge Elimination System
NR	Not Reported
NRC	National Research Council
NTP	National Toxicology Program
NTU	Nephelometric Turbidity Unit
OERR	Office of Emergency and Remedial Response
OIA	Other Impacted Area
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OVA	Organic Vapor Analyzer
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated biphenyl
PCT	Porphyria Cutanea Tarda
PDE	Potential Dietary Exposure
PEM	Performance Evaluation Mixture
pg/g	Picogram per gram
pg/L	Picogram per liter
POTW	Publicly Owned Treatment Works
ppb	Parts per billion
PPE	Personal Protective Equipment
ppm	Parts per million
ppt	Parts per trillion
PRC	Preliminary Risk Characterization
PRG	Preliminary Remedial Goal
PSA	Preliminary Site Assessment
psi	Pounds per square inch
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-Based Concentration
RBSL	Risk-Based Screening Level
RCRA	Resource Conservation and Recovery Act
RDA	Recommended Daily Allowance
RFA	RCRA Facility Assessment
RfC	Reference Concentration
RfD	Reference Dose
RFI	RCRA Facility Investigation
RGO	Remedial Goal Option
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference
RRF	Relative Response Factor

RTV	Reference Toxicity Value
SAA	Satellite Accumulation Area
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SDG	Sample Delivery Group
SF	Slope Factor
SFF	Site Foraging Factor
SMCL	Secondary Maximum Contaminant Level
SOUTHDIV	Southern Division Naval Facilities Engineering Command
SRL	Significant Risk Level
SSL	Soil Screening Levels
SSV	Sediment Screening Value
SVE	Soil Vapor Extraction
SVOA	Semivolatile Organic Analysis
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
TCDD	Tetrachlorodibenzo-p-dioxin
TCE	Trichloroethene
TD-GS/MS	Thermal Desorption-Gas Chromatography/Mass Spectrometry
TD/MS	Thermal Desorption/Mass Spectrometry
TDS	Total Dissolved Solids
TEF	Toxic Equivalency Factor
TEQ	TCDD Equivalency Quotient
TIC	Tentatively Identified Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
TTAL	Treatment Technique Action Level
TU	Temporary Unit
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UTL	Upper Tolerance Limit
UV	Ultraviolet
UXO	Unexploded Ordinance
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WBZ	Water-Bearing Zone
WQC	Water Quality Criteria

$\mu g/cm^2$	Microgram per square centimeter
$\mu g/g$	Micrograms per gram
$\mu g/kg$	Microgram per kilogram
$\mu g/L$	Microgram per liter
%R	Percent Recovery
%RSD	Percent Relative Standard Deviation
%D	Percent Difference
2,4-D	2,4-Dichlorophenoxyacetic acid
2,4-DB	2,4-Dichlorophenoxybutyric acid
2,4,5-T	2,4,5-Drichlorophenoxyacetic acid
2,4,5-TP	Silvex

EXECUTIVE SUMMARY

The environmental investigation and remediation at Naval Base Charleston are required by the Hazardous and Solid Waste Amendments portion of the Resource, Conservation and Recovery Act, Part B permit. For management purposes, Naval Base Charleston has been geographically divided into 12 investigative "zones" identified as A through L. The following report addresses the RCRA Facility Investigation for Zone H.

The objective of the investigation is to characterize the nature and extent of contaminants associated with releases from sites identified as Solid Waste Management Units and Areas of Concern, evaluate contaminant migration pathways, and to identify both actual and potential receptors. The goal is to determine the need for Interim Measures or a Corrective Measures Study.

Fifty-three sites were identified in Zone H through the RFA process. Of the 53 sites, 31 Solid Waste Management Units and Areas of Concern were identified as needing further assessment in the RCRA Facility Investigation. The remaining 22 were classified as needing no further action. The sampling and analysis plan which described the methods to be used for site characterization was outlined in the *Final Zone H RCRA Facility Investigation Work Plan*. The investigation was conducted between August, 1994 and April, 1995. Media sampled included soil, sediment, groundwater, surface water, and air. This report also incorporates data from environmental investigations which preceded the RCRA Facility Investigation. The site assessments were accomplished by comparison of sample results to a combination of background and risk based screening values. Background was established by non-site related sampling on a grid basis using an algorithm that decreased sampling frequency by increasing the spatial distance between points as the distance from individual sites increased. This method allowed determination of natural background values of inorganics as well as establishing the ubiquity of certain organics. Compounds or elements which exceeded either background and/or risk based screening values were retained for further evaluation in accordance with the guidelines established in the *Final Comprehensive Baseline Risk Assessment Work Plan*. Areas of Concern

503 and 661 (Unexploded Ordnance and Explosives Storage) have yet to be investigated. These sites are scheduled for survey by the Navy explosive ordinance disposal teams. The environmental investigation must take into consideration the health and safety aspects of not only exposure to contaminants but, also the potential explosion hazards that exist with sites of this nature. For this reason, no intrusive sampling can be performed until the surveys are complete.

Generally, the baseline risk assessment is divided into two subsections - human health risk and ecological risk. The baseline risk assessment analyzes the potential adverse effects, on actual or hypothetical receptors, that could arise from exposures to hazardous substances released from a site if no remedial actions are taken to mitigate or reduce levels of contaminants present. Compounds or elements present at concentrations which pose an unacceptable risk or hazard are identified as either "chemicals of concern" or "ecological chemicals of potential concern". It should be noted that a chemical of concern with respect to human health may not be an ecological chemical of potential concern and vice-versa. The value of the risk assessment process is that it facilitates risk management decisions by providing remedial goal options for each of the chemicals of concern identified in the various media. Exceedances of remedial goal options at a site does not necessarily mean that remedial measures will be needed.

The human health risk assessment evaluated two scenarios, hypothetical site worker (industrial land use) and hypothetical site resident (potential future residential land use). The risk assessment concluded that under the residential scenario, surface soil may pose an unacceptable risk/hazard SWMUs 14, 15, 17, 19, 20, 121, 178, and 159 and AOCs 649, 650, 655, 656, 663 (and SWMU 136), 665, 666, 670, and 684 and OIAs G07, G38, and G80. Shallow groundwater may pose an unacceptable risk/hazard at SWMUs 9, 13, 14, and 17 and AOCs 656, 653, 655, 663 (and SWMU 136), and 666. Deep groundwater may pose and unacceptable risk/hazard at SWMUs 9, and 14. Petroleum hydrocarbon contamination of soil exceeds the action level of 100 ppm at SWMUs 13, 14, 17, 19, 121, 178, 159, and AOCs 649, 650, 656, 653, 655, 659, 663 (and SWMU 136), 665, 667 (and SWMU 138), and 666. Risks or hazards have tentatively been deemed unacceptable if contaminant concentrations resulted in an incremental excess lifetime cancer risk of 1×10^{-6} or a hazard index of 1 was exceeded.

For purposes of the ecological risk assessment, Zone H was divided into four "subzones" (H-1, H-2, H-3, and H-4) on the basis of habitat type. Subzones H-1 through H-3 are upland areas and H-4 is a marsh area. A portion of Zone H was excluded from the ecological risk assessment on the basis that it is heavily industrialized and suitable habitat for ecological receptors is conspicuously absent. Potential risks for ecological receptors within these subzones were evaluated for exposure to surface soil, surface water, and sediment at Zone H. Risks associated with exposure to ecological chemicals of potential concern in surface soil were evaluated for terrestrial wildlife based on a model that predicts the amount of contaminant exposure via the diet and incidental ingestion of soil. Comparison of predicted doses for representative wildlife species with doses representing thresholds for both lethal and sublethal effects is the basis of the risk evaluation. Risks for soil invertebrates and plants were evaluated based on qualitative comparisons to literature effects-levels for taxonomic groups similar to those potentially occurring at Zone H. Risks for aquatic organisms were evaluated by calculating hazard quotients from benchmark values that are either promulgated or proposed by federal and state regulatory agencies.

The ecological risk assessment concluded the following for each of the subzones:

H-1 Potential lethal and sublethal effects from inorganics exists for terrestrial wildlife species. Young herbaceous vegetation is also at risk from elevated metal contamination. A potential risk to soil infaunal organisms is also predicted due to the presence of polynuclear aromatic hydrocarbons.

H-2 Potential lethal and sub-lethal effects to Eastern cottontail rabbit exposed to soil metal concentrations in sub-zone are predicted by the model. Potential sub-lethal effects to American robin from metals in soil are predicted. Lead, copper, and zinc soil concentrations detected at sub-zone H-2 may pose a risk to early seedlings and infaunal invertebrates.

H-3 Potential lethal and sublethal effects from inorganics exist for terrestrial wildlife species. A potential risk to infaunal organisms from soil lead and PAH concentrations is predicted.

H-4 No risks are predicted to aquatic receptors in surface water of Shipyard Creek. Potential risks to aquatic receptors does exists from sediment contamination in Shipyard Creek. For both inorganic and organic ecological chemicals of potential concern, hazard quotient values were above one. Copper and zinc may pose a risk to young herbaceous plants.

The report makes recommendations for inclusion of sites in the Corrective Measures Study. Residential risk greater than 1E-6 or residential hazard HQ greater than 1.0 for either soil or groundwater, and significant ecological risk constituted inclusion into the CMS. TPH concentrations greater than 100 mg/kg also constituted inclusion into the CMS. The final decision as to which sites will be carried forward into the Corrective Measures Study will be made by the risk managers which are the State and Federal regulatory agencies. The thresholds for determining whether or not sites are recommended for the Corrective Measures Study were conservatively set as contaminant concentrations which result in greater than 1×10^{-6} excess incremental lifetime cancer risk to potential future site residents, a hazard index greater than 1, or concentrations of total petroleum hydrocarbons in excess of 100 parts per million. These action levels were established by the NAVBASE Charleston BRAC Cleanup Team. Based on these levels, the following sites have been recommended for inclusion in the CMS: SWMUs 9, 14 (including SWMU 15 and AOCs 670 and 684), 13, 15, 17, 19, 20, 121, 159, and 178; AOCs 649, 650 (including the area of 651), 653, 655, 656, 659, 663 (and SWMU 136), 665, 666, 667 (and SWMU 138); and, the other impacted areas of G07, G38, and G80. AOCs 654, 660, and 662 were recommended for no further action.

1.0 INTRODUCTION

The environmental investigation and remediation at Naval Base Charleston (NAVBASE) are required by the Hazardous and Solid Waste Amendments (HSWA) portion of the Resource Conservation and Recovery Act (RCRA) Part B permit. The purpose of the investigation is to evaluate the nature and extent of hazardous wastes or constituent, and to identify, develop, and implement an appropriate corrective measure or measures to protect human health and the environment. The scope of the RCRA Facility Investigation (RFI) includes the entire Naval Base, which has been subdivided into zones (Zone A through L) to accelerate the RFI process. This report for Zone H of NAVBASE, prepared by EnSafe/Allen & Hoshall (E/A&H), is submitted to satisfy condition II.C.6 of the HSWA portion of the Part B permit.

1.1 NAVBASE Description and Background

Location

NAVBASE is in the city of North Charleston, on the west bank of the Cooper River in Charleston County, South Carolina (Figure 1.1). This installation consists of two major areas: an undeveloped dredged materials area on the east bank of the Cooper River on Daniel Island in Berkeley County, and a developed area on the west bank of the Cooper River (Figure 1.2). The developed portion of the base is on a peninsula bounded on the west by the Ashley River and on the east by the Cooper River. Major commands that occupy areas of the base include Charleston Naval Shipyard, Fleet Ballistic Missile Submarine Training Center, Fleet and Industrial Supply Center, Fleet and Mine Warfare Training Center, Naval Hospital Charleston, and Naval Station (Figure 1.3). NAVBASE also includes the degaussing facility in downtown Charleston, the Shipboard Electronics System Evaluation Facility on Sullivan's Island, and the Naval Station Annex adjacent to the Charleston Air Force Base.

The areas surrounding NAVBASE are "mature urban," having long been developed with commercial, industrial, and residential land uses. Commercial areas are primarily west of

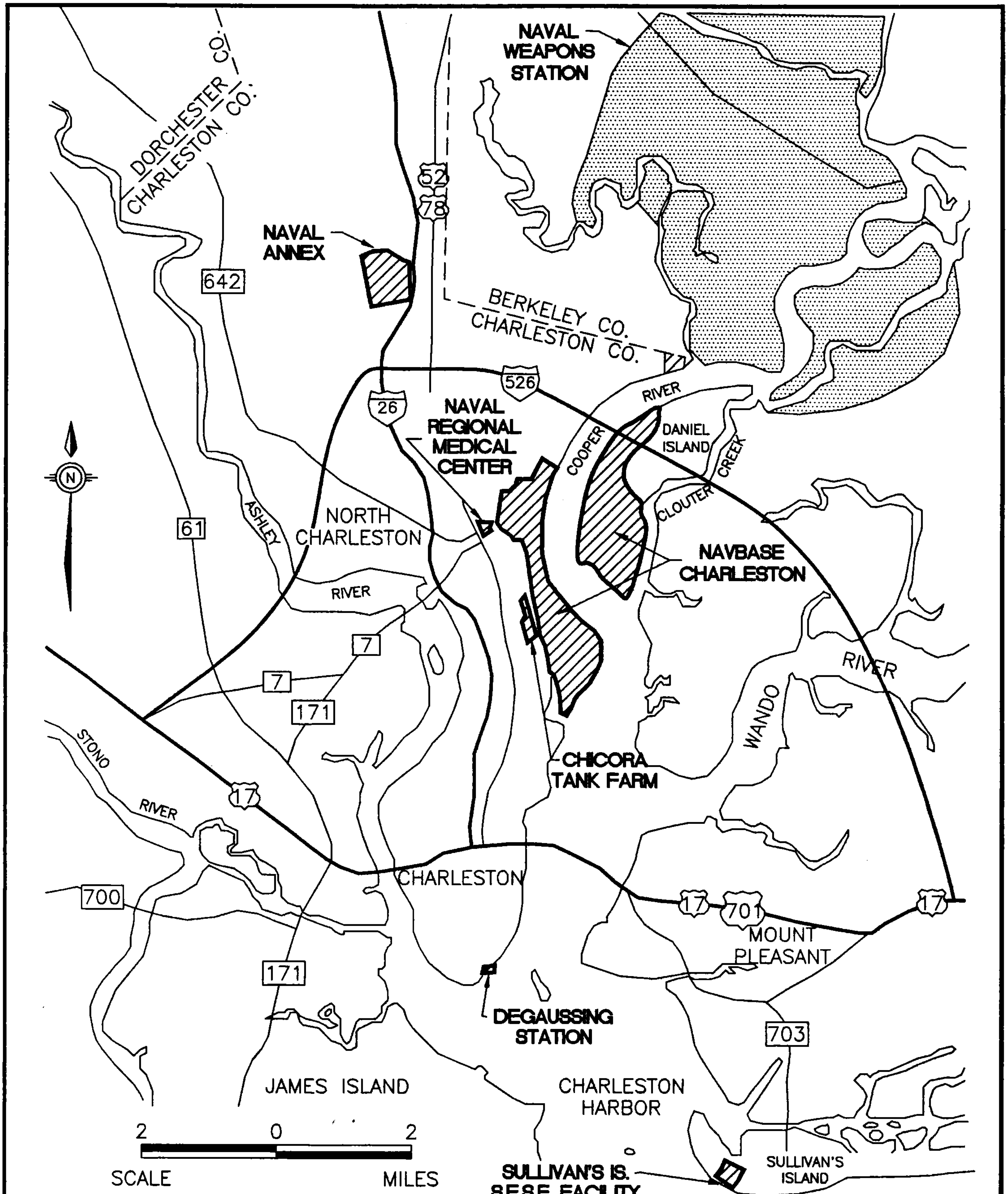
NAVBASE; industrial areas lie primarily to the north of NAVBASE and along the west bank of Shipyard Creek.

The area west of Shipyard Creek is concentrated with heavy industry, and has been for many years. Railways have served the area since the early 1900s. Railways and nearby waterways have made the area ideal for heavy industry. While ownership has changed from time to time, the land adjacent to NAVBASE remains dedicated to chemical, fertilizer, oil refining, metallurgy, and lumber operations.

In contrast, the east bank of the Cooper River is undeveloped with extensive wetlands, particularly along Clouter Creek and Thomas Island. Active dredged materials disposal areas are on Naval property between the Cooper River and Clouter Creek.

History

In 1901, the U.S. Navy acquired 2,250 acres near Charleston to build a naval shipyard, and the first naval officer was assigned duty in early 1902. A work force was organized, the Navy Yard surveyed, and construction of buildings and a drydock began. The drydock was finished in 1909, along with several other brick buildings and the main power plant, which are still in use today. With a work force of approximately 300 civilians, the first ship was placed in drydock and work began on fleet vessels in 1910. World War I brought about an expansion of the yard's facilities, land area, and work force. The yard built two gunboats, several subchasers, and tugs in addition to performing repairs and other services to the fleet. The future of the shipyard was uncertain following the war, when employment levels dropped. The year 1933 marked the beginning of an upsurge at the yard. A larger workload, principally in construction of several Coast Guard tugs, a Coast Guard cutter, and a Navy gunboat, created the need for more facilities and a much larger work force.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 1.1
LOCATION MAP
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA

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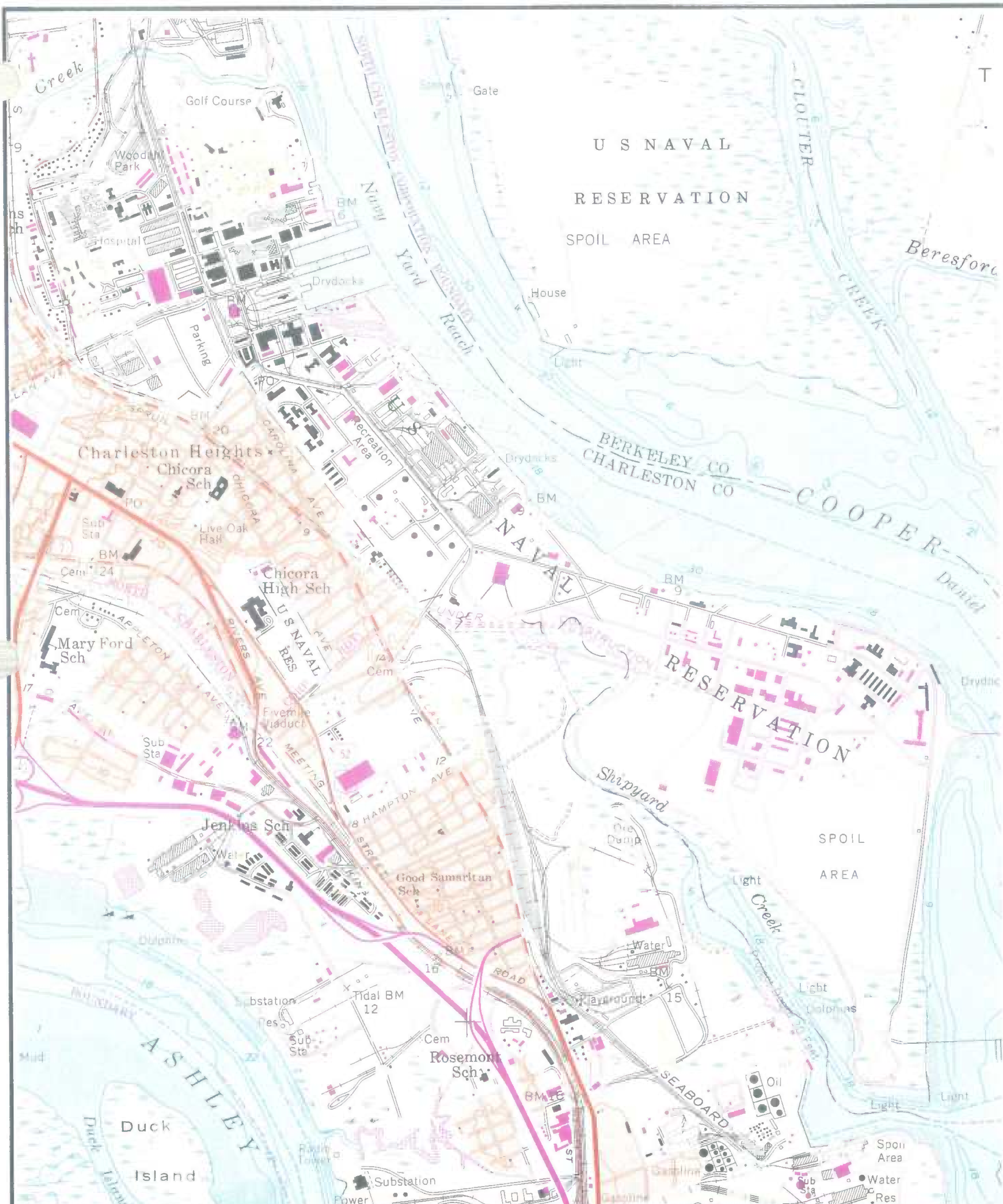

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 1.2
NAVAL BASE CHARLESTON
VICINITY MAP

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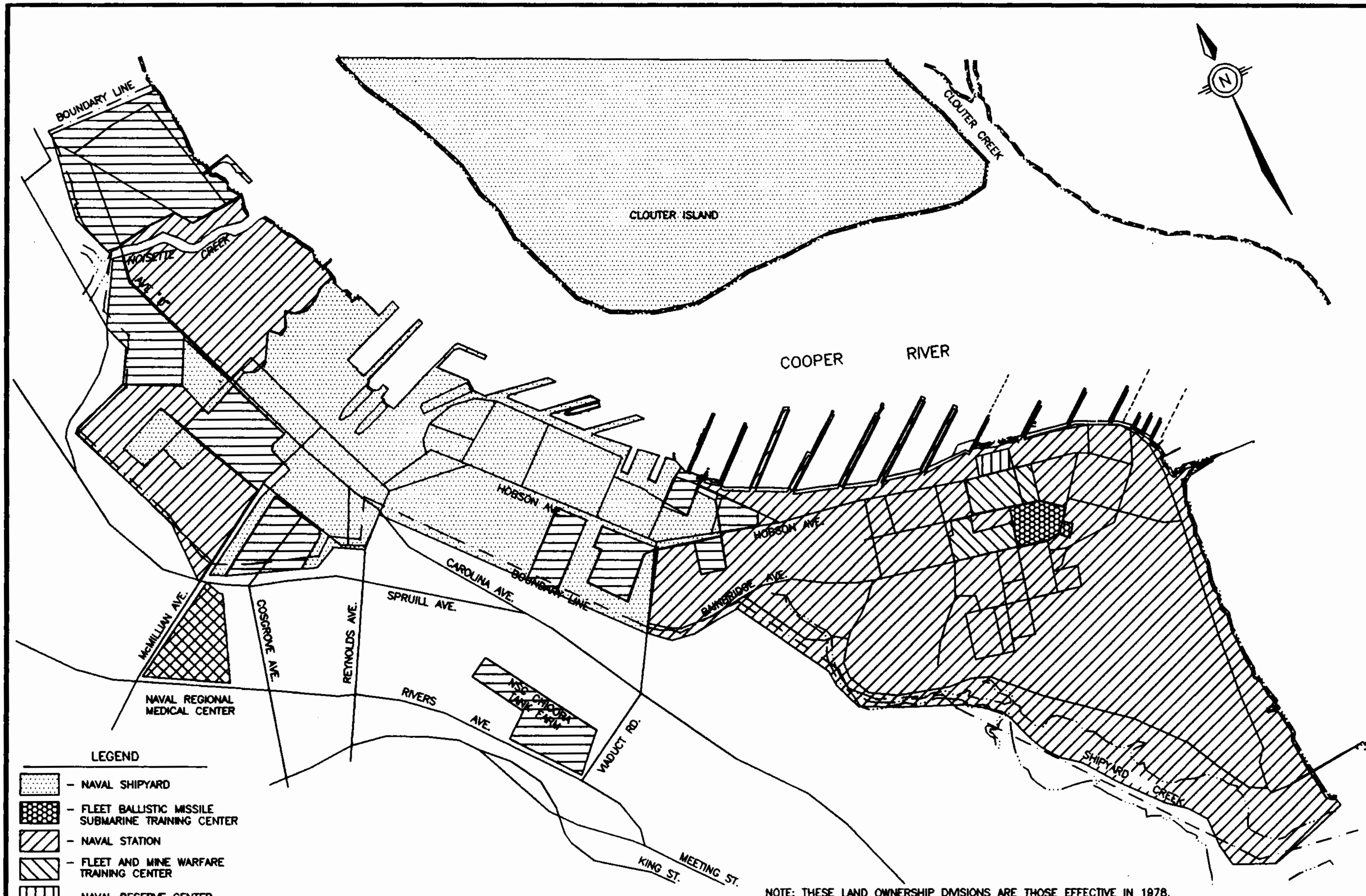

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 1.3
LOCATIONS OF
LAND HOLDINGS AND OCCUPANTS

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Civilian employment peaked in 1943 with almost 26,000 employees divided among three daily shifts. In 1956, construction began on piers, barracks, and buildings for mine warfare ships and personnel. Later in the decade, Charleston became a major homeport for combatant ships and submarines of the U.S. Atlantic Fleet.

Base Closure

Today, due in part to the end of the cold war and major cuts in defense spending, NAVBASE is in the process of shutting down operations. In 1993, NAVBASE was added to the list of bases scheduled for closure under the Defense Base Closure and Realignment Act (BRAC), which regulates the closure and transition of property to the community. Since the base was scheduled for closure, operations have been scaled back and environmental cleanup has begun to make the property available for redevelopment after closure on April 1, 1996.

1.2 Base Closure Process for Environmental Cleanup

The Installation Restoration Program

In 1980, The Department of Defense established the Installation Restoration Program (IRP) to investigate and clean up contamination which may have resulted from past operations, storage, and disposal practices at federal facilities nationwide. The Navy adopted this program, which has regulatory requirements similar to those developed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Although federal installations were not required to comply with this act until it was amended in 1986, the Navy has, in effect, been complying with its environmental regulations through participation in the IRP since 1980.

Resource Conservation and Recovery Act

The primary focus of NAVBASE's environmental cleanup activities fall under RCRA, which was passed by Congress to control the handling of hazardous materials and wastes, and to set standards for hazardous waste generation, transportation, treatment, storage, and disposal. NAVBASE was issued a hazardous waste permit in 1990 in accordance with this act, allowing the base to operate within these guidelines. Hazardous materials include substances such as chemicals, pesticides, petroleum products, and some paints and cleaners the U.S. Environmental Protection Agency (USEPA) identifies as being potentially harmful to human health or the environment.

The NAVBASE hazardous waste permit covers the investigation and cleanup of individual sites, called solid waste management units (SWMUs) and areas of concern (AOCs), resulting from past hazardous waste spills. SWMUs and AOCs are defined in the Part B permit as follows:

- SWMU — "Any unit which has been used for the treatment, storage, or disposal of solid waste at any time, irrespective of whether the unit is or ever was intended for the management of solid waste. RCRA-regulated hazardous waste management units are also solid waste management units. SWMUs include areas that have been contaminated by routine and systematic releases of hazardous constituents, excluding one-time accidental spills that are immediately remediated and cannot be linked to solid waste management activities (e.g., product or process spills)."

- AOC — "Any area having a probable release of a hazardous waste or hazardous constituent which is not from a solid waste management unit and is determined by the Regional Administrator to pose a current or potential threat to human health or the environment. Such areas of concern may require investigations and remedial actions as required under Section 3005(c)(3) of the Resource Conservation and Recovery Act and 40 CFR §270.32(b)(2) in order to ensure adequate protection of human health and the environment."

Where appropriate in this document, SWMUs and AOCs are collectively referred to as "sites."

The investigation and cleanup activities are referred to as "corrective measures." The main steps of the corrective measures process are outlined below.

- *RCRA Facility Assessment (RFA)* identifies potential or actual contamination releases through a records review and visual examination of every SWMU and AOC.

- *RCRA Facility Investigation (RFI)* confirms contamination and determines its nature. This investigation also examines the extent and rate of any migration, provides a baseline risk assessment and baseline data for the evaluation of corrective measures.

- During a *Corrective Measures Study (CMS),* cleanup alternatives for the site are developed and evaluated. This study also recommends a preferred cleanup option or corrective measure.

- During *Corrective Measures Implementation (CMI),* the selected corrective measure is designed, constructed, operated, maintained, and monitored for performance.

- *Interim Corrective Measures (ICMs)* are used to stabilize, control, or limit further releases from a site. Interim measures can be imposed at any point in the process.

1.3 Investigative Zone Delineation

Due to the size of the base and the level of detail required for investigations, NAVBASE has been divided into 12 investigative zones, identified as A through L, as shown in Figure 1.4. The order in which zones will be investigated and cleaned up has been determined in conjunction with the Restoration Advisory Board and the BEST (Building Economic Solutions Together) committee (a board authorized by the state to study and report on the best reuse options for the property being transferred). In 1994, BEST was replaced by the Charleston Naval Complex Redevelopment Authority, which has authority to establish leases for the transferred property.

Zone H is in the southern portion of the peninsula formed by Shipyard Creek and the Cooper River. The zone is bounded by Hobson Avenue to the north; Shipyard Creek to the south; Osprey Street, C.B. Lane, and the dredged materials area to the east; and Halsey Street, Bainbridge Avenue, and property boundaries to the west. Zone H contains properties identified for transfer to the State Department as well as Naval support activities, training areas, and administrative areas.

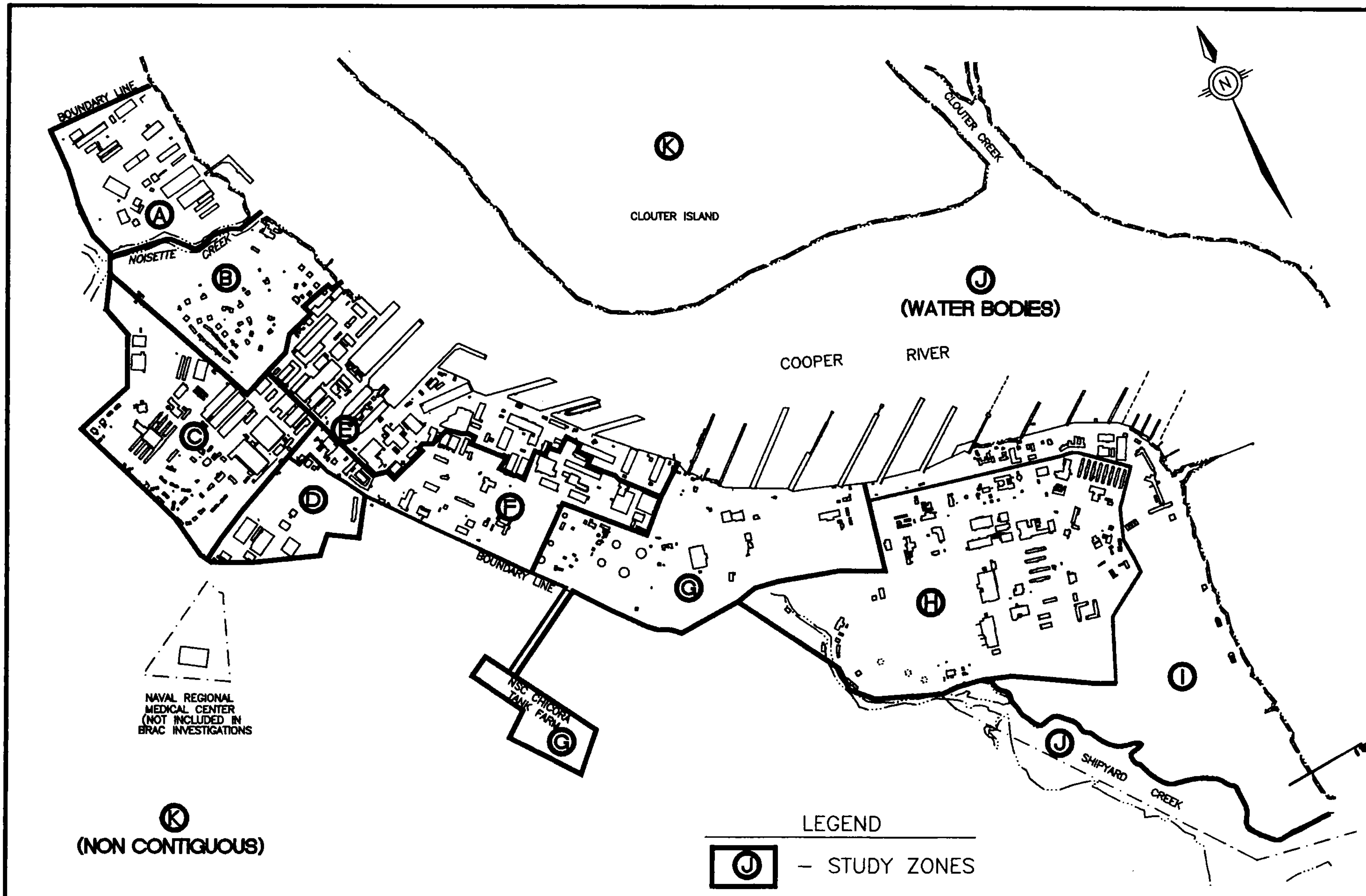
1.4 Current Investigation

Objective

The objectives of the RFI are to characterize the nature and extent of contaminants associated with releases from SWMUs and AOCs, evaluate contaminant migration pathways, and to identify both actual and potential receptors. The ultimate goal is to determine the need for ICMs or a CMS. This need will be evaluated by conducting a Baseline Risk Assessment (BRA) to assess the risks posed to human health and the environment by individual sites and/or groups of sites within a zone.

Scope

Fifty-three sites were identified in Zone H through the RFA process. A detailed discussion of each site in Zone H can be found in the RFA (E/A&H, 1995b). Recommendations for investigative approach at each site were made based on the best available information at that time and are subject to change should additional information become available that would substantiate a change. These investigatory designations are as follows:



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SCALE FEET

SOURCES: SOUTHDIV, n.d. ESE, 1981.

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 1.4
INVESTIGATIVE
ZONE BOUNDARIES

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No Further Investigation (NFI) — This designation was applied to an AOC or SWMU if, based on the RFA process, there was no reason to suspect that a release had ever occurred. These sites were not included in the Zone H RFI.

Confirmatory Sampling Investigation (CSI) — A CSI was performed due to evidence of past releases, potential migration pathways, or a lack of a thorough assessment of the hazards associated with the SWMU/AOC, as determined through the RFA process. Generally, a limited amount of "confirmatory" samples were needed to either determine whether a hazard exists. Confirmatory sampling will determine whether no further investigation is appropriate or a full-scale RFI is warranted. If a SWMU/AOC was within the boundaries of another SWMU/AOC considered for a CSI or RFI, it was incorporated into the RFI of the larger site.

RCRA Facility Investigation — An RFI was performed if historical information suggested that an event(s) capable of environmental impact occurred, analytical data from past investigations indicated the presence of contamination, or if additional work is considered necessary to more accurately assess impact. If a SWMU/AOC was within the boundaries of another SWMU/AOC considered for an RFI, it was incorporated into the RFI of the larger site.

Of the 53 SWMUs and AOCs identified, 30 were deemed as needing further investigation. The *Final Zone H RFI Work Plan* (E/A&H, 1994b) outlined an investigative strategy for each site designated as CSI or RFI. The investigations of SWMU 159, AOC 661, and AOC 503 were incomplete when the first draft of this report was prepared. Figure 1.5 identifies the sites. SWMU 159 was a late addition to the RFI; consequently, a revision to the work plan was required and the sampling efforts did not occur concurrently with the other sites. However, samples have been collected and data have been received from the analytical laboratory, and incorporated into this report. Evaluations of AOCs 661 and 503 are to be performed by a Naval explosive ordnance disposal (EOD) team before transfer of NAVBASE property. Table 1.1 briefly describes each SWMU and AOC in Zone H requiring further investigation and its investigative approach.

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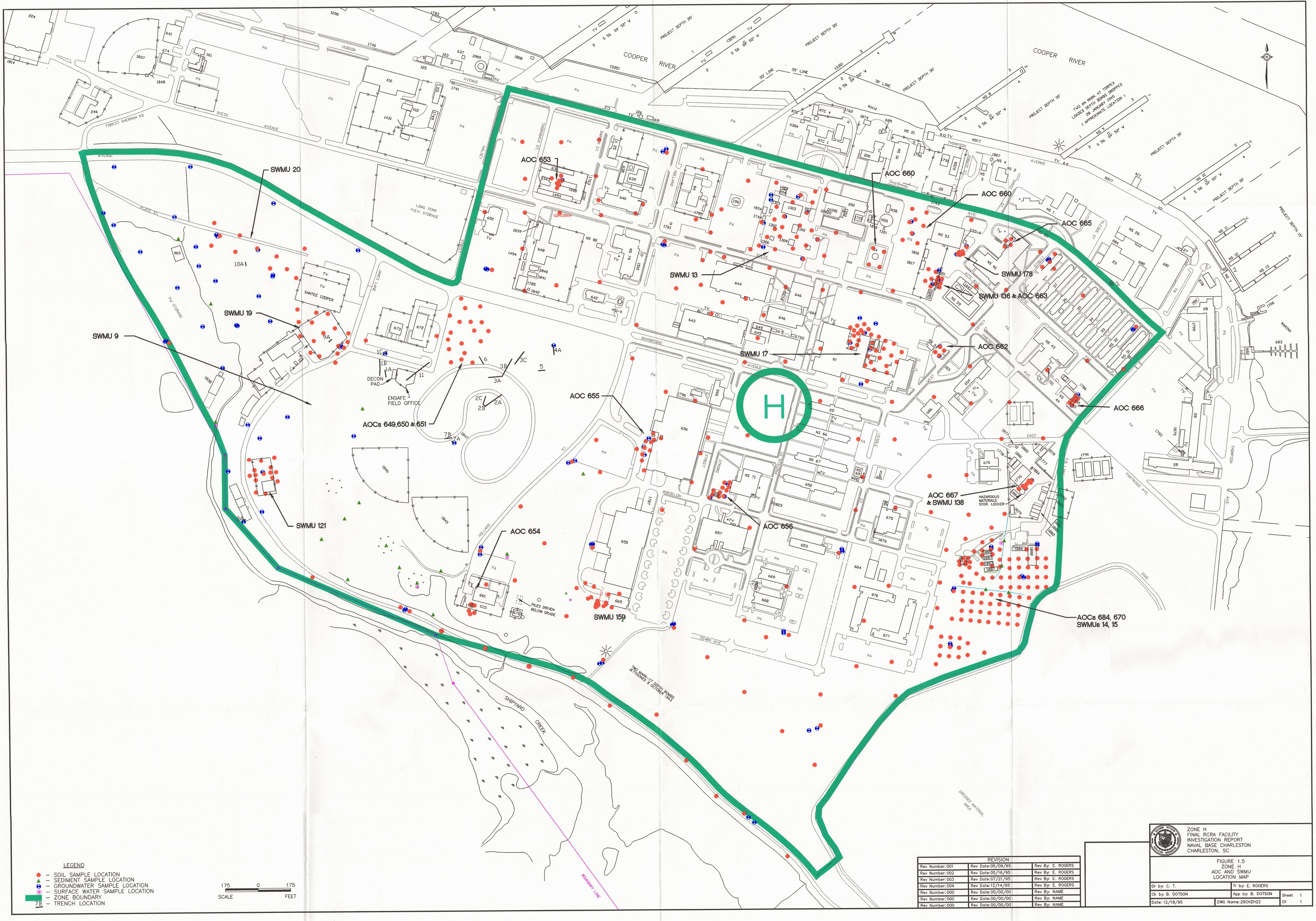

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 1.5
ZONE H
AOC AND SWMU
LOCATION MAP

REVISION		
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Dr by: C. T.	Tr by: E. ROGERS	
Ck by: B. DOTSON	App by: B. DOTSON	Sheet 1
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Table 1.1
Zone H SWMUs and AOCs with Investigatory Designations

Zone H AOCs and SWMUs	Site Description	Investigative Approach	Investigation Grouping
SWMU 9	Closed Landfill	RFI	This group of AOCs and SWMUs was combined for the groundwater assessment investigation as SWMU 9. Soil contamination was assessed for each SWMU or AOC within the SWMU 9 area.
SWMU 19	Solid Waste Transfer Station	RFI	
SWMU 20	Waste Disposal Area	RFI	
SWMU 121	Satellite Accumulation Area, Building 801	RFI	
AOC 649	Braswell Shipyards, Inc., Storage Area	CSI	
AOC 650	Metal Trades, Inc., Storage Area	CSI	
AOC 651	Sandblasters, Inc., Storage Area	CSI	
AOC 654	Septic Tank and Drain Field 1718, Building 661	CSI	
SWMU 13	Current Fire Fighter Training Area	RFI	Investigated Independently
SWMU 14	Chemical Disposal Area	RFI	This group of AOCs and SWMUs was combined for investigation as SWMU 14.
SWMU 15	Incinerator	RFI	
AOC 670	Former Skeet Range, South of Building 1897	RFI	
AOC 684	Former Outdoor Pistol Range, Building 1888	RFI	
SWMU 17	Oil Spill Area	RFI	Investigated Independently
SWMU 159	Satellite Accumulation Area, Building 665, CNSY Permit 90	RFI	Investigated Independently
SWMU 178	Site of Apparent Transformer Fire Outside of Building NS-53	CSI	Investigated Independently
AOC 503	Unexploded Ordnance (UXO) Site South of Building 665	RFI	To Be Investigated
AOC 661	Explosives Storage	CSI	To Be Investigated
AOC 653	Hobby Shop, Building 1508	CSI	Investigated Independently
AOC 655	Oil Spill Area, Building 656	RFI	Investigated Independently
AOC 656	Petroleum Spill Between Buildings 602 and NS-71	RFI	Investigated Independently

Table 1.1
Zone H SWMUs and AOCs with Investigatory Designations

Zone H AOCs and SWMUs	Site Description	Investigative Approach	Investigation Grouping
AOC 659	Diesel Storage, Building 14	CSI	Investigated Independently
AOC 660	Mosquito Control, Former Building 31	CSI	Investigated Independently
AOC 662	Former Gasoline Station, Building NS-54	CSI	Investigated Independently
AOC 663	Gas/Diesel Pumping Station, Building 851	CSI	This AOC and SWMU were investigated together.
SWMU 136	Building NS-53 Satellite Accumulation Area 19	CSI	
AOC 665	Pyrotechnic Storage, Building 159	CSI	Investigated Independently
AOC 666	Fuel Storage, Building NS-45	CSI	Investigated Independently
AOC 667	CBU 412 Vehicle Maintenance Area, Building 1776	RFI	This AOC and SWMU investigated together.
SWMU 138	Satellite Accumulation Area, Building 1776	CSI	

1.5 Previous Investigations

In addition to data generated during the current investigation, information from investigations conducted in Zone H prior to its RFI were reviewed while preparing this report. Pertinent data have been incorporated where appropriate. Table 1.2 lists previous investigations applicable to the Zone H RFI.

Table 1.2
Previous Investigations of Zone H SWMUs and AOCs

Number	Previous Investigations	Activities	Contaminants Identified
SWMU 9	Initial Assessment Study, 1981; Confirmation Study, 1982; Environmental Investigation Fire Fighting Training Facility (Westinghouse, 1991); Preliminary geophysical, soil-gas, soil, sediment, and groundwater studies (E/A&H, 1994). Analytical data to be included with this report.	Geophysical and soil-gas surveys; trenching; soil, groundwater, and sediment sampling.	Volatile organic compounds (VOCs), pesticides/poly-chlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), and metals.
SWMU 14	Confirmation Study, 1982; preliminary geophysical and soil-gas study (E/A&H, 1994).	Geophysical and soil-gas surveys; soil and groundwater sampling.	Tetrachloroethane (Soil-gas)
SWMU 17	Soil samples collected and analyzed following 1987 fuel oil release.	Soil sampling	PCBs and petroleum hydrocarbons
SWMU 19	Preliminary geophysical, soil-gas, soil, sediment, and groundwater studies (E/A&H, 1994). Analytical data to be included with this report.	Geophysical and soil-gas surveys; trenching; soil, groundwater, and sediment sampling.	Insufficient data to confirm whether contamination was present.
SWMU 20	Preliminary geophysical, soil-gas, soil, sediment, and groundwater studies (E/A&H, 1994). Analytical data to be included with this report.	Geophysical and soil-gas surveys; trenching; soil, groundwater, and sediment sampling.	VOCs
AOC 653	Zone Inspection Report for Zone 22 (July 31, 1991)	Visual inspection	Oil residue and petroleum hydrocarbons
AOC 655	Passive soil-gas investigation conducted with initial Focused Field Investigation (FFI) response.	Passive soil gas sampling using PETREX™ technology.	Relatively high soil-gas responses for benzene, toluene, ethylbenzene, and xylene (BTEX), acetone, and other oil compounds were detected near the reported oil spill.
AOC 656	Passive soil-gas investigation conducted with initial FFI response.	Passive soil-gas sampling using PETREX™ technology.	Relatively high soil gas responses for acetone, BTEX compounds, and other oil compounds were detected in the vicinity of the site.

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2.0 FIELD INVESTIGATION

The sampling strategy for each SWMU and AOC within Zone H, as detailed in the Final Zone H RFI Work Plan (E/A&H, 1994b), was designed to consider:

- The environmental quality of NAVBASE as a whole.
- Possible impacts of one SWMU or AOC on another SWMU or AOC.
- Benefits to be gained at one SWMU/AOC by sampling at another.
- The possibility of environmental contamination migrating onto and/or off NAVBASE.
- Specific data needs for various potential presumptive remedies which are necessary to design the CMS.
- Data needs of other related activities such as the BRA.
- Specific need for each piece of data.
- A minimum of mobilization.
- The presence of data gaps from previous investigations.

Field activities were conducted in compliance with the Final Comprehensive, Sampling and Analysis Plan (CSAP) (E/A&H; 1994a) and the *USEPA Region IV Environmental Services Division Standard Operating Procedures and Quality Assurance Manual* (ESDSOPQAM) (USEPA Region IV, 1991). Sampling and investigatory methodologies used during the Zone H

RFI investigation are summarized in this section. All chain-of-custody forms generated during Zone H sampling are included as Appendix A.

2.1 Sample Identification

All samples collected during this investigation were identified using the 10-character scheme specified in Section 11.4 of the CSAP (E/A&H, 1994a). This scheme identifies the samples by site, sample matrix, location, sample depth. The first three characters identify the site where the sample was collected. The fourth character identifies the matrix or quality control (QC) code for the sample. The fifth, sixth, seventh, and eighth characters identify the sample location. The ninth and tenth characters identify the soil sample depth or sample interval. For example: sample 013SB00402 is a second-interval soil sample from Boring 004 at SWMU 013. For the groundwater samples; the ninth and tenth characters identify the sampling sequence. For example, 653GW00101 is the first groundwater sample collected from monitoring well 001 at AOC 653.

2.2 Soil Sampling

Section 4 of the CSAP (E/A&H, 1994a) details the methods used to sample soil. The following subsections summarize those procedures.

2.2.1 Soil Sample Locations

Soil samples were collected based on the proposed locations identified in the Final Zone H RFI Work Plan (E/A&H, 1994a), analytical data resulting from first and second rounds of soil sampling, and sample location's accessibility. The sample locations proposed in the Final Zone H RFI Work Plan were based on the investigation strategy outlined in Section 1.2 of that document. Each SWMU and AOC primary sampling pattern is justified in Subsections 4.1 through 4.21 of the Final Zone H RFI Work Plan. Some proposed sample locations were modified slightly due to utility locations. A few locations were deemed inaccessible due to the thickness of concrete overlying the soil.

Additional samples were required at some sites to adequately characterize contaminant distribution. Following interpretation of analytical data for samples collected during the initial round of soil sampling, a second round of sample collection was proposed in some areas. A few locations required a third round of sample collection. Typically, additional sample locations were justified due to relatively high concentrations of contaminants on the perimeter of the previous sampling pattern.

2.2.2 Soil Sample Collection

Composite soil samples were generally collected for laboratory analysis from 0 to 1 foot below ground surface (bgs) and from 3 to 5 feet bgs. The 0- to 1-foot bgs interval is referred to in this report as the 01 or upper interval sample. At soil sample locations overlain by pavement, the surface interval was collected from the base of the pavement to 1 foot below the base. The 3- to 5-foot bgs interval is referred to as the 02 or lower interval sample. No other sample intervals were collected due to the relatively shallow depth to groundwater in Zone H. Groundwater is typically encountered from 2 to 6 feet bgs at NAVBASE. No saturated soil samples were retained for laboratory analysis.

Stainless-steel hand augers were used to collect soil samples. At sodded locations, the sod (generally less than 2 inches thick) overlying the soil sample at the 01 interval was removed prior to augering down to 1 foot bgs. As the auger filled with soil, it was removed from the hole and the contents were placed in stainless-steel mixing bowls. This process was completed until the entire interval had been sampled. The 02 sample interval was collected using a clean decontaminated auger following the same procedures used for the 01 interval sample. A concrete coring machine was utilized at numerous locations to provide access to soil covered by concrete and/or asphalt.

2.2.3 Soil Sample Preparation, Packaging, and Shipment

Guidelines contained in Section 11 of the CSAP were followed for the preparation, packaging, and shipment of soil samples collected during the Zone H RFI investigation. The following briefly summarizes those activities.

Upon placement of the soil sample into the stainless-steel mixing bowl, a portion of the sample was packed into a sample jar for volatile organics analysis (VOA). Following VOA sample preparation, the remaining material was homogenized and the appropriate sample containers were filled using stainless-steel spoons. The remaining soil was used to backfill the auger hole from which it was removed. Any portion of the auger hole remaining open was then filled with bentonite pellets which were hydrated in place.

Soil samples were identified as described in Section 2.1 and in compliance with Section 11.4 of the CSAP (E/A&H, 1994a). From the moment of collection, sample identifications accompanied each sample container. Pertinent information such as date and time of sample collection, weather, sampling team, sketch map of sample location, and analytical parameters were recorded in the Zone H soil sampling logbook for each sample or group of samples collected.

At the close of each day of sampling, soil samples were grouped by sample identification, custody sealed, enclosed in waterproof plastic bags, encased in protective bubblewrap, and placed in a sample cooler. Ice, enclosed in two waterproof plastic bags, was placed on top of the samples to preserve them at approximately 4°C. Before sealing the sample cooler for shipment, all sample data were entered onto an official chain-of-custody form which was then affixed to the top, inside surface of the sample cooler.

Sample coolers were shipped by air for next-day delivery to Pace Laboratories, New Hampshire.

2.2.4 Soil Sample Analysis

All first-round soil samples were analyzed for the following USEPA parameter list: volatile organic compounds (VOCs) (Method 8240), semivolatile organic compounds (SVOCs) (Method 8270), pesticides/polychlorinated biphenyls (PCBs) (Method 8080), cyanide (Method 9010), and metals (Methods 6010, 7060 [As], 7421 [Pb], 7470 [Hg], 7740 [Se], 7841 [Tl]). During the second and third rounds of sampling, analytical parameters were reduced to focus only on those compounds defined as chemicals of potential concern (COPCs) by the first round of sampling. Soil samples collected near the chemical disposal area were analyzed for Appendix IX parameters which include hexavalent chromium, dioxins, herbicides, organophosphate pesticides, in addition to the more comprehensive lists of VOCs, SVOCs, and pesticides/PCBs. Sample analyses were performed and data reported in accordance with USEPA Data Quality Objectives (DQO) Level 3 guidelines. In areas where petroleum hydrocarbon contamination was suspected, soil samples were also analyzed for total petroleum hydrocarbons (TPH) by USEPA Methods 418.1 and 8015, modified.

Approximately 10% of the soil samples collected at Zone H were duplicated and also submitted for Appendix IX analytical parameters. Duplicate samples were analyzed and data reported in accordance with USEPA DQO Level 4 guidelines. The purpose of Appendix IX sampling was two-fold: 1) provide a measure of reassurance that the sampling scheme was not inadvertently overlooking any compounds potentially present; 2) provide a quality assurance/quality control (QA/QC) check on the DQO Level 3 data.

Upon identification of the presence of significant (relative to the risk-based screening levels) concentrations of constituents of concern based on analytical data from the first and second soil sampling events, locations were identified at which to collect soil samples to provide engineering parameter data for the CMS and Section 5 of this report. These samples were analyzed for the following USEPA and American Society for Testing and Materials (ASTM) parameters:

• Cation Exchange Capacity	USEPA SW-846 Method 9080, 9081
• Organic Content	USEPA SW-846 Method 9060
• pH	USEPA SW-846 Method 9045
• Nitrate	USEPA SW-846 Method 9056
• Nitrite	USEPA SW-846 Method 9056
• Ammonia	USEPA 350
• Phosphorus (total)	USEPA 365.1
• Sulfur (percent)	ASTM D 129-64
• Chlorides (percent)	ASTM D 2015-77
• Bulk Density	ASTM D 1587-83
• Soil Moisture	ASTM D 2216-80
• Unsaturated Hydraulic Conductivity	ASTM D 2434-68
• Grain Size Analysis	ASTM D 422-63
• Hydrometer Analysis	ASTM D 422
• Porosity	Sowers and Sowers, 1951

2.3 Monitoring Well Installation and Development

Section 5 of the CSAP (E/A&H, 1994a) describes methods used to install and develop monitoring wells. All monitoring wells were installed after well permits were acquired from South Carolina Department of Health and Environmental Control (SCDHEC). The following subsections briefly summarize those methodologies.

Monitoring wells installed as a portion of the Zone H RFI investigation were identified according to the following convention. All identification numbers for monitoring wells installed during the Zone H investigation consist of 10 characters. The first three characters (*NBC* for all wells) identify the wells as Naval Base Charleston wells. The fourth character identifies the investigatory zone in which the monitoring wells were installed. (*H* in this case). Characters 5, 6, and 7 identify the site at which the monitoring wells were installed. For example, monitoring wells installed in the vicinity of SWMU 9 contain *009* as the fifth, sixth, and seventh characters. For monitoring wells installed as part of the grid-based sampling network of Zone H, the well identifications will contain *GDH* as the fifth, sixth, and seventh characters. The eighth, ninth, and tenth characters in the monitoring well identification scheme identify the individual well number. For example, the individual well identification for the fifth well to be installed at SWMU 9 was *005*. If the tenth character is *D*, the monitoring well is a deep well. Three complete examples of typical monitoring well identifications are as follows. *NBCH013005* is the number 005 well at SWMU 13 at Naval Base Charleston. *NBCHGDH04D* is the deep well at the number 04 grid-based sampling location in Zone H of Naval Base Charleston. *NBCHGDH001* is the number 001 grid-based monitoring well in Zone H at Naval Base Charleston.

2.3.1 Shallow Monitoring Well Installation

The shallow monitoring wells were installed to facilitate groundwater sampling in the upper portion of the shallow aquifer. These monitoring wells were installed using the hollow-stem auger drilling and monitoring well construction methods. Drilling involved augering to the total depth of the borehole using hollow-stem auger flights tipped with a lead auger head. The total depth of the shallow wells depended primarily on depth to groundwater. Every effort was made to bracket the water-table surface at each shallow monitoring well location. However, this was not always possible due to the shallow depth to groundwater. Given that groundwater was encountered at approximately 2 to 6 feet bgs across NAVBASE, the typical depth of a shallow monitoring well was approximately 13 to 14 feet.

Two-foot split-spoon samples were collected for lithologic characterization at 5-foot intervals from each shallow monitoring well borehole. These soil samples were visually classified and screened for organic vapors by the onsite geologist. These samples were not retained for chemical analysis. Typical split-spoon sample intervals in shallow monitoring well boreholes were from 3 to 5 feet bgs, 8 to 10 feet bgs, and 13 to 15 feet bgs. A sample representing the lithology of the typical screened interval for each SWMU/AOC was retained for grain-size analysis from one well boring at each site.

Typical shallow monitoring well construction involved placing a 10-foot section of 2-inch inside diameter (ID) polyvinyl chloride (PVC) screen with 0.010-inch slots attached to 10 feet of 2-inch ID PVC riser pipe down the inside of the hollow-stem auger after having drilled to the desired depth. Filter pack material was then poured into the annular space between the hollow-stem auger and PVC to approximately 2 feet above the top of the screened section. As the sand was added, the level in the borehole annulus was measured with a weighted tape. The hollow-stem auger sections were withdrawn while the sand was added to allow uniform placement of the filter pack and to avoid bridging and raising the well screen and riser casing with the augers. Care was taken to never raise the hollow-stem auger sections higher than the level of filter pack in the borehole, to ensure that no formation material slumped into the borehole against the well screen. Bentonite pellets were emplaced from the top of the filter pack to ground surface and hydrated with potable water. After allowing sufficient time for the bentonite to hydrate, typically 24 hours, the surface mount was constructed. Groundwater protection was provided in the interim through use of locking well caps in the inside diameter of the PVC riser pipe.

A boring log documenting the lithology encountered and as-built well information for each shallow monitoring well is located in Appendix B.

Temporary monitoring wells were installed near SWMUs 20 and 121 in the SWMU 9 area during the RFI to provide screening level data for positioning permanent monitoring wells. Hydropunch technology was attempted before temporary well installation, but was discontinued due to the lithologic properties of SWMU 9 sediments. The clay and silt content of the sedimentary deposits in the SWMU 9 area prohibited groundwater from entering the Hydropunch sampling device. After several failed attempts to collect groundwater using that device, installing temporary monitoring wells was judged to be an appropriate method to obtain screening level quality data from a large area for which very little data were available.

Appropriate permits were obtained from SCDHEC before constructing the temporary wells. The temporary monitoring wells were installed following the same procedures as outlined for permanent shallow monitoring wells except that surface mounts were not constructed. A bentonite seal of minimum 1-foot thickness was installed at the top of each filter pack and extended to ground surface. This bentonite was hydrated with potable water. A locking well cap was placed on the PVC riser pipe stickup, which extended approximately 2 to 3 feet above ground surface. The temporary wells remained locked until they were purged prior to sampling.

Following sampling, the temporary wells were abandoned by pulling the PVC riser casing and screen from the borehole and filling the portion that did not collapse with high-solids bentonite grout.

2.3.2 Deep Monitoring Well Installation

Deep monitoring wells were installed to facilitate groundwater sampling at the base of the shallow aquifer. Review of regional geology identified the Ashley Formation of the Cooper Group as the shallowest formation most capable of retarding or preventing downward flow of water and/or contaminants. This formation is widely noted in the Charleston area for its low permeability and its effectiveness as a confining layer over the underlying Santee Limestone. Deep monitoring wells were installed in the shallow aquifer at the contact with the underlying Ashley Formation.

Rotosonic drilling, which was used to install the deep monitoring wells, combines standard rotary action with sonic vibration. The vibrations are created at the surface and directed to the subsurface through the drill string. The sonic vibration displaces formation material rather than removing cuttings back to the surface as with more traditional drilling methods. The continuous core sample produced with the rotosonic method provides extremely accurate lithologic characterization. Soil samples were logged and classified as described in Section 2.3.1. Core sections, 10 to 20 feet long, were typically produced, depending on anticipated proximity to the target formation.

After target depth identification, monitoring well construction would proceed much like monitoring well construction through hollow-stem augers. A 10-foot section of 2-inch ID, 0.010-inch factory slot, PVC screen was installed with the base of the screen at the contact between the Ashley Formation and the overlying Pleistocene sediments. Attached to the screen was an appropriate length of 2-inch ID PVC riser casing. Filter pack sand was placed to approximately 2 feet above the screened interval and settled by activating the sonic vibration. A bentonite seal of a minimum 3-foot thickness was emplaced on top of the filter pack and also settled with vibratory action and then hydrated. The remaining interval of borehole was then tremied to the surface with high-solids bentonite grout.

A portion of the deep monitoring wells installed in Zone H deviate from the construction standard proposed in the Final Zone H RFI Workplan. These wells were constructed with excessive filter pack material extending below their screened interval. The following wells have been identified as having excessive filter pack:

- NBCH00904D
- NBCH00905D
- NBCH00906D
- NBCH00912D
- NBCH01401D
- NBCH01405D
- NBCHGDH01D
- NBCHGDH02D

- NBCHGDH07D
- NBCHGDH11D

The practice of backfilling with filter pack material, when overdrilling in the Ashley Formation occurred, was not followed during subsequent zone investigations.

In each of the above-listed wells, with the exception of NBCH01405D and NBCHGDH11D, an apparently transmissive zone was present in the interval which was screened. Typically, the inference of being transmissive was due to the presence of a well sorted shell hash and/or sand. When overdrilling occurred it was always into the Ashley Formation (Cooper Marl) and the Ashley Formation was never penetrated. Several samples of the Ashley Formation were submitted for physical parameter analysis. The average hydraulic conductivity of the Ashley Formation samples was 1.2×10^{-6} centimeters per second (cm/sec). No samples were collected for physical parameter analysis from the interval directly above the top of the Ashley Formation due to the noncohesive nature of the material and thus the inability to obtain a competent sample. Due to the presence of the shelly and/or sandy nature of the material present within the screened interval, and that overdrilling only occurred in material with low hydraulic conductivities, and the Ashley Formation was not penetrated (reported to be 200-300 feet thick), water removed while sampling would be representative of the screened interval.

Wells NBCH01405D and NBCHGDH11D did not exhibit the typical shelly and/or sandy zone directly overlying the Ashley Formation. There was 12 and 7 feet, respectively, of excess filter pack in each one of these wells. Marsh clay was present down to the top of the Ashley Formation in both wells. Hydraulic conductivities for the marsh clay averaged 2.5×10^{-6} cm/sec. Although there is greater potential with these two wells that a portion of the water in the samples originated from within the top of the Ashley Formation, it should be noted that both logs describe the Ashley Formation as "dry" providing support of the representativeness of the groundwater samples. All boring logs for deep wells include the descriptive term "dry" for the Ashley Formation or directly name it the Cooper Marl.

Boring logs in Appendix B document the lithology encountered and as-built well construction information for each deep monitoring well.

2.3.3 Monitoring Well Protector Construction

The well protectors installed were of either the flush-mount, manhole-type, or abovegrade protective casing, depending on the well's location. Well protectors were installed in accordance with Section 5.4 of the CSAP (E/A&H, 1994a).

At locations where vehicular traffic was expected, as in parking lots, a flush-mount well protector was installed. At all other locations, abovegrade steel protective casings were installed. In the case of flush mounts, a 2-foot by 2-foot section of material, typically concrete or asphalt, was removed from around the borehole to approximately 6 inches in depth. A 8-inch ID, 8-inch deep, flush-mount cover with a bolt-down manhole cover was then placed over the capped well. The top of the completed well cover was generally 2 inches above adjacent surfaces. Concrete was added to fill the 2-foot by 2-foot excavated area and mounded to provide a sloped surface away from the top of the flush-mount cover to the adjacent surface. A monitoring well identification tag containing the well number, date installed, drilling subcontractor, total well depth, and depth to water was mounted onto the sloped concrete surface of each flush-mount pad. Expansion caps and keyed-alike locks were placed on each monitoring well with a flush-mount cover.

Abovegrade well protectors were prepared by installing a 3.5-foot long, 4-inch by 4-inch square section of steel protective surface casing approximately 1 to 1.5 feet down over the PVC riser pipe. Care was taken not to compromise the integrity of the bentonite seal overlying the filter pack material. The protective casings were hinged approximately 6 inches from the top to allow access to the top of the PVC riser pipe. The hinged covers for each abovegrade protective casing were designed to be locked. A 4-foot by 4-foot concrete pad approximately 6 to 8 inches thick was then constructed around each protective casing. Weep holes were drilled through the well protector to allow for drainage and venting. A 3-inch diameter bumper post was set at each corner of the pad. A monitoring well identification tag containing the well number, date installed, drilling subcontractor, total well depth, and depth to water was mounted onto the hinged cover of each abovegrade well protector. Each hinged cover is secured with keyed-alike locks.

2.3.4 Monitoring Well Development

Monitoring wells were developed by initially stressing the filter pack by surging and subsequently purging with a pump to lower the turbidity and stabilize the parameters of conductivity, pH, and temperature. Well development adhered to Section 5.5 of the CSAP (E/A&H, 1994a).

Surging involved the following steps:

1. Decontaminated PVC rods were attached to a surge block.

2. The surge block was lowered into the monitoring well screen section.

3. The surge block was then raised and lowered so groundwater would surge in and out of the monitoring well screen.

4. Surging was conducted for approximately 10 to 15 minutes per well.

5. The surge block was removed from the well for decontamination.

Pumping of shallow monitoring wells involved the following steps:

1. Decontaminated polyethylene tubing was lowered into the well.

2. The tubing was attached to a pump at the surface and pumping began. A pitcher pump was used at deep well locations where centrifugal pumps could not lift water to the surface.

3. If the productivity of the monitoring well was low, it would be alternately pumped then left idle to recover. The onsite geologist determined when development was complete using the following guidelines.

4. Monitoring wells were developed until the water column was as free of turbidity as possible given the subsurface conditions, and until the pH, temperature, and specific conductivity were stabilized to satisfy the following criteria. A minimum of three well volumes of groundwater were removed from each well during development.

Temperature:	within ± 1.0°C
pH:	within ± 0.5 standard unit
Conductivity:	within ± 10 percent from the duplicate
Turbidity:	generally between 10 and 30 nephelometric turbidity units (NTUs) or relatively stable (± 15 NTUs)

2.4 Groundwater Sampling

Section 6 of the CSAP (E/A&H, 1994a) describes groundwater sampling methods. The following subsections briefly summarize those procedures. Copies of groundwater sampling forms completed during each sampling event are included in Appendix C.

2.4.1 Groundwater Sampling Locations

Groundwater samples were collected from well locations based on the approved locations identified in the Final Zone H RFI Work Plan (E/A&H, 1994b), analytical data resulting from the first and second rounds of soil sampling, and the first round of groundwater sampling. Some proposed locations were moved slightly due to accessibility and utilities.

Additional wells were required at some sites to determine the extent of groundwater contamination. Following analysis and interpretation of groundwater analytical data for samples collected from the initial wells, additional monitoring well locations were proposed. Typically, additional sample locations were justified due to relatively high concentrations of contaminants on the perimeter of the previous sampling pattern.

2.4.2 Groundwater Sample Collection

Groundwater sampling was conducted in accordance with Section 6 of the CSAP (E/A&H, 1994a) after the wells were allowed to recover from development for two weeks. The following steps outline the typical process of monitoring well sampling.

1. Decontaminated sampling equipment and supplies were transported to the monitoring well to be sampled.

2. A temporary work area was established around each well. Plastic sheeting was placed on the sampling table and around the well to be sampled. Personal protective equipment (PPE) was donned in accordance with the approved health and safety plan (HASP) for the monitoring well to be sampled.

3. The condition and security of the monitoring well were noted. The monitoring well was unlocked and the well cap removed. Headspace was immediately measured for VOCs using an organic vapor analyzer (OVA). The breathing zone was also monitored prior to and during sampling with an OVA.

4. Depth to water and total depth of the well were measured using an oil-water interface probe if OVA readings, odor, or other indicators suggested a light nonaqueous phase liquid (LNAPL) on the water surface. A water-level meter was used if no LNAPL was suspected. All measurements were recorded to the nearest 1/100th of a foot. Static water-level measurements were taken from the top of casing at a point notched into the well. Well volumes were calculated and all measurements and observations recorded. Water-level measurement equipment was decontaminated immediately after each use.

5. New decontaminated Teflon tubing was installed in the well. The tubing extended into the well and, depending on a sufficient water level in the well, positioned above the screened interval. A peristaltic pump was positioned at the surface and the tubing mounted through the pump. Groundwater was purged into graduated buckets or containers for volume measurements, which were recorded in the field logbook.

6. At one, two, and three well-volume intervals, the parameters of temperature, pH, conductivity, and turbidity were measured and recorded. Groundwater conditions typically stabilized during this purging period. Stabilization of temperature, pH, and conductivity was defined by variation of 10% or less between the last two readings. Turbidity values were monitored with the intent to achieve readings of less than 10 NTUs. Purging would continue for up to five well volumes with the intent of stabilizing the parameters of temperature, pH, and conductivity and achieving less than 10 NTUs for turbidity. Wells that were purged dry, due to slow recovery, were sampled after 12 hours of recovery. Purging some wells to achieve turbidity of less than 10 NTUs was not possible due to lithologic variabilities. For example, at wells installed in areas with increased silt content, it was typically more difficult to achieve a turbidity of less than 10 NTUs.

7. After purging, groundwater samples were collected according to the analytical parameters proposed for each groundwater sample.

The first-quarter groundwater samples were collected using a vacuum container placed in-line between the well and the pump. Sample water was pulled into this container from which the appropriate sample containers were filled. VOA samples were collected by capping the surface end of the Teflon tubing and allowing gravity to drain water out of the end of the tubing into the VOA vials. Second quarter groundwater samples were collected without the use of a vacuum container from the discharge side of the pump after having gone through Tygon tubing within the pump. VOA samples were obtained by capping the Tygon tubing and raising it from the well and allowing the contents of the tube to drain into the sample containers. All tubing used during sampling was new and decontaminated. No tubing was dedicated or reused. The procedure followed in collecting second round groundwater samples deviated from the procedure outlined in the Final Zone H RFI Workplan. This deviation involved the use of Tygon tubing to remove sample water from the well rather than Teflon tubing. This deviation was corrected prior to the third round of groundwater sampling. A comparison of analytical results for equipment rinsate blanks collected during the first, second, and third rounds of groundwater sampling is provided in Table 2.1.

Equipment rinsate blanks collected during groundwater sampling were collected through the same sampling procedure as the groundwater samples. Deionized water is pumped from a decontaminated stainless steel container through the sampling tubing into the appropriate sample containers.

Based on the data summarized in Table 2.1, there is no apparent change in analytical data results for samples collected through Teflon tubing or Tygon tubing. Equipment rinsate blanks collected during the first round and third round of groundwater sampling were drawn through decontaminated Teflon tubing into a glass vacuum container prior to being poured into sample

Table 2.1
Zone H Groundwater Sample Equipment Blank Contaminant Comparison
VOC and SVOC Analytical Results for First, Second, and Third Round Equipment Rinsate Blank Samples (all results reported in μg/L)

First Quarter		Second Quarter		Third Quarter	
Sample ID	**VOC and SVOC Hits**	**Sample ID**	**VOC and SVOC Hits**	**Sample ID**	**VOC and SVOC Hits**
GDHEW00501	bis(z-ethylexyl)phthalate (BEHP) — 28.9	009EW00202	Methylene Chloride — 5 J Chloroform — 2.2 J Di-n-butylphthalate — 2.6 J	009EW01203	Chloroform — 6 BEHP — 91
178EW00101	Acetone — 10.9 Methylene Chloride — 7.8 BEHP — 15	009EW08D02	Methylene Chloride — 4 J Chlorobenzene — 2.7 BEHP — 26	667EW00103	Acetone — 13 J Chloroform — 4.8 J No SVOC Detections
009EW00101	Chlorobenzene — 1.1 J Methylene Chloride — 5 J BEHP — 44.2	GDHEW00302	No VOC Analysis No SVOC Detections	GDHEW11D03	Butylbenzylphthalate — 4.6 J BEHP — 2.2 J No VOC Detections
		014EW05D02	Chloroform — 6 No SVOC Analysis	009EW00703	Methylene Chloride — 29 J Chlorobenzene — 9 J BEHP — 7.3 J
		655EW00102	No VOC Analysis No SVOC Detections		
		013EW00702	No VOC Analysis No SVOC Detections		

bottles. Equipment rinsate blanks collected during the second round of groundwater sampling were drawn through decontaminated Tygon tubing directly into the sample container. No VOCs or SVOCs were detected in the equipment rinsate blanks collected during the second round that were not also detected in equipment rinsate blanks from the first and/or third round of groundwater sampling.

Groundwater samples were identified in accordance with Section 2.1 of this report and Section 11.4 of the CSAP (E/A&H, 1994a).

Temporary monitoring wells were purged prior to sampling using a bailer. At least three well volumes of water were removed from the temporary wells prior to sampling. The pH, conductivity, and temperature were measured during sampling. Samples from temporary wells were collected with clean, unused disposable Teflon bailers.

2.4.3 Groundwater Sample Preparation, Packaging, and Shipment

Guidelines in Section 11 of the CSAP (E/A&H, 1994a) were followed for the preparation, packaging, and shipment of groundwater samples collected during the Zone H RFI investigation. The following briefly summarizes those activities.

Groundwater samples were preserved according to laboratory criteria for parameters being collected. Appropriate labels and custody seals were completed and affixed to each sample bottle. Glass sample containers were encased with bubblewrap and enclosed in a resealable plastic bag to protect during shipment. Plastic/polyethylene sample containers were also placed in a resealable plastic bag. Immediately after sample collection and identification, sample containers were placed on ice in coolers prior to transport to the field trailer. Records of sampling were entered into a dedicated field logbook and a master logbook stored in a fireproof safe in the site trailer.

Before shipping them to the laboratory, the samples were transferred into a shipping cooler to lessen possible breakage. All samples were placed into a waterproof plastic bag prior to placement in the cooler. Bubblewrap was placed on the bottom of each of the coolers. Enough ice, enclosed in two waterproof plastic bags, was placed along the sides and on top of each group of bagged samples to ensure a temperature of approximately 4°C during shipment. Temperature blanks were included with each sample shipment to monitor sample temperature upon arrival at the laboratory. Chains-of-custody were prepared daily and accompanied each sample cooler shipment. Two custody seals were affixed to each sample cooler prior to shipment. Sample coolers were shipped by air for next-day delivery to Pace Laboratories.

2.4.4 Groundwater Sample Analysis

All first-round groundwater samples were analyzed using the following USEPA, SW-846 methods: VOCs (Method 8240), SVOCs (Method 8270), pesticides/PCBs (Methods 8080), cyanide (Method 9010), and metals (Method 6010, 7060 [As], 7421 [Pb], 7470 [Hg], 7740 [Se], and 7841 [Tl]). Where petroleum hydrocarbon contamination was suspected, a portion of the SWMU- and AOC-specific samples was analyzed for TPH (Method 418.1 and Method 8015, modified). Groundwater samples from near the chemical disposal area (SWMU 14) were analyzed for Appendix IX parameters, which include hexavalent chromium, dioxins, herbicides, organophosphate pesticides, in addition to more comprehensive lists of VOCs, SVOCs, and pesticides/PCBs. During the second and third rounds of sampling, analytical parameters were reduced to focus only on those compounds defined as COPCs by the first round of sampling.

Only VOA samples were collected from the temporary wells.

Groundwater samples were collected from several grid-based monitoring wells within Zone H and analyzed for engineering parameters relevant to the CMS. These parameters include:

• Temperature	Measured during sample collection
• pH	Measured during sample collection
• Biological Oxygen Demand	USEPA Method 405.1
• Chemical Oxygen Demand	USEPA Method 410.1, 410.2, or 410.3
• Alkalinity	USEPA Method 310.2
• Hardness	USEPA Method 130.2
• Total Suspended Solids	USEPA Method 160.2
• Total Dissolved Solids	USEPA Method 160.1
• Total Organic Carbon	USEPA Method 415.1
• Nitrate	USEPA Method 352.1
• Nitrite	USEPA Method 354.1
• Ammonia	USEPA Method 350.1
• Phosphorus (Total)	USEPA Method 365.1

Ten percent of the groundwater samples collected at Zone H were duplicated and submitted for Appendix IX analytical parameters.

The zone-wide second round of quarterly groundwater sampling was conducted during April 1995. The results of this round of sampling are also included in this report.

2.5 Sediment and Surface Water Sampling

Section 7 of the CSAP (E/A&H, 1994a) describes methods to collect sediment and surface water samples. The following subsections briefly summarize those procedures.

2.5.1 Sediment and Surface Water Sample Locations

Sediment and surface water samples were collected from the approved locations identified in the Final Zone H RFI Work Plan. All sediment and surface water sample locations were accessible by wading at the time of sample collection. Surface water samples were collected before sediment samples.

2.5.2 Sediment and Surface Water Sample Collection

Composite sediment samples were collected for laboratory analysis from 0 to 6 inches bgs. Sediment samples were collected using the scoop sampling methods outlined in Section 7.2.3 of the CSAP (E/A&H, 1994a). Surface water samples were collected in accordance with Section 7.3 of the CSAP.

Stainless-steel spoons and bowls were used to collect sediment samples. When the sample location was identified, the sediment surface was removed with a decontaminated stainless-steel spoon or spatula to expose a previously unexposed surface. Using a clean decontaminated stainless-steel spoon, the sediment was scooped into a decontaminated stainless-steel bowl. For VOC samples, the sample containers were filled directly from the sampling device, taking care to avoid twigs, large rocks, and grass. The remaining material was homogenized in the bowl and placed into the appropriate sample containers.

Surface water samples were collected by submerging the appropriate sample containers with the open end in the upstream direction. Care was taken not to disturb bottom sediments during the sample procedure. VOC samples were collected first in the series of sample containers.

2.5.3 Sediment and Surface Water Sample Preparation, Packaging, and Shipment

Guidelines in Section 11 of the CSAP (E/A&H, 1994a) were followed for the preparation, packaging, and shipment of sediment and surface water samples collected during the Zone H RFI investigation. The following briefly summarizes those activities.

Sediment and surface water samples were identified as outlined in Section 11.4 of the CSAP. From the moment of collection, sample identifications accompanied each container for each sample. Samples were stored on ice in a cooler until prepared for shipment. Pertinent information such as sample date and time of sample collection, weather, sampling team, sketch map of sample location, tidal phase, and analytical parameters were recorded in the Zone H sampling logbook for each sample or group of samples collected.

At the close of each day of sampling, sediment and surface water samples were grouped by sample identification, custody sealed, enclosed in waterproof plastic bags, encased in protective bubblewrap, and placed in a sample cooler. Ice in two waterproof plastic bags was placed on top of the samples to preserve them at approximately 4°C. Before sealing the sample cooler for shipment, the official chain-of-custody form was affixed to the top, inside surface of the cooler. The coolers were then secured and two custody seals were affixed prior to shipment.

Sampling records were entered into a dedicated field logbook and a master logbook stored in a fireproof safe at the site trailer.

Sample coolers were shipped by air for next-day delivery to Pace Laboratories.

2.5.4 Sediment and Surface Water Sample Analysis

All sediment samples were analyzed using the following USEPA, SW-846, Third Edition method parameters: total organic carbon (TOC) (Method 415.1, 415.2) (SWMU 9 and SWMU 159), organotins (laboratory standard operating procedure), VOCs (Method 8240), SVOCs (Method 8270), pesticides/PCBs (Method 8080), cyanide (Method 9010), and metals (Method 6010, 7060 [As], 7412 [Pb], 7470 [Hg], 7740 [Se], and 7841 [Tl]). A portion of the sediment samples was duplicated and analyzed for Appendix IX parameters, such as hexavalent chromium, dioxins, herbicides, organophosphate pesticides, and more comprehensive lists of VOCs and SVOCs.

All surface water samples were analyzed for the following list of parameters by USEPA methods: VOCs (Method 8240), SVOCs (Method 8270), pesticides/PCBs (Method 8080), metals (Method 6010, 7060 [As], 7412 [Pb], 7470 [Hg], 7740 [Se], and 7841 [Tl]), and cyanide (Method 9010). A portion of the surface water samples was also duplicated and analyzed for the Appendix IX parameters. Field parameters (dissolved oxygen, temperature, pH, conductivity, and salinity) were not measured during Zone H surface water sampling. These parameters will be measured and recorded during any Zone J surface water sampling.

Grain size analyses were not conducted on the sediment samples collected at SWMU 9 as proposed in the Final Zone H RFI Workplan. Grain size analyses are to be conducted as a portion of the sediment mapping exercise proposed in the Zone J RFI Workplan.

2.6 Aquifer Characterization

Between November 9 and December 9, 1994, rising and falling head slug tests were conducted on 19 shallow and six deep monitoring wells to enhance estimates of aquifer characteristics. Before a slug test was initiated, the static water level in each well was measured using an electronic water-level indicator. A "slug" was then instantaneously introduced into the well, at which time the water level and the time (T_0) were recorded. Periodically, water level/elapsed time measurements were recorded as the head fell back to the original level. Similarly, each rising head slug test was performed by removing the "slug" and recording water level/elapsed time measurements as the head rose back to normal. The time required for a slug test to be completed and the water level rate of change are functions of hydraulic conductivity.

The slugs consisted of 5-foot and 6-foot, 1.5-inch diameter solid Teflon cylinders with stainless-steel eyebolts attached at one end. A nylon rope tethered to the eyebolt suspended the slug in the well just above or below the water level. At the beginning of each test, the data logger was activated the instant the slug was either lowered into or removed from the water.

For each slug test, InSitu pressure transducers and two-channel Hermit 1000C data loggers were used to record water level/elapsed time measurements. For graphing data, the data loggers were programmed to record water level measurements on a logarithmic time scale. Raw data from the data loggers were downloaded to a personal computer for data reduction and manipulation.

Data from the slug tests were compiled using the computer program AQTESOLV (Aquifer Test Solver) by the Geraghty and Miller Modeling Group (1989). AQTESOLV has several widely published and accepted analytical solutions for many different kinds of aquifer tests. Rising and falling head slug test data from shallow wells were plotted using an unconfined aquifer solution. For this solution, time (elapsed) versus displacement (change in water level) was plotted on semilogarithmic graph paper. Hydraulic conductivity (K) was computed by the program using an equation developed by Bouwer and Rice (1976) for unconfined aquifers.

Data from deep wells were plotted using two different confined aquifer solutions because some of the wells match one solution better than the other. One confined aquifer solution is a slightly different version of the Bouwer and Rice unconfined aquifer solution mentioned above. The other is a confined aquifer solution by Cooper, Bredehoeft, and Papadopulos (1967) which uses time (elapsed) plotted against changes in head on semilogarithmic graph paper to calculate aquifer transmissivity (T) and storativity (S). The AQTESOLV graphs are presented in Appendix D of this report.

Variables on the graphs are:

H0	=	initial displacement in the well due to slug injection or extraction
rc	=	well casing radius
rw	=	wellbore radius
L	=	length of the well screen
b	=	thickness of the aquifer

H	=	static height of water in the well
K	=	hydraulic conductivity
y0	=	Y intercept
T	=	transmissivity
S	=	storage coefficient

Transmissivities from the Cooper et al. confined solution were converted to hydraulic conductivity values with the following relationship:

$$K=\frac{T}{b}$$

Where: K = hydraulic conductivity
T = transmissivity
b = aquifer thickness

A length of 10 feet was used for the aquifer thickness (b) in the formula above. This is roughly the thickness of the lower sand zone. Where the lower sand is absent, the screen is 10 feet long as well.

2.7 Vertical and Horizontal Surveying

Monitoring well locations and elevations were determined by conventional plane surveying techniques. The horizontal and vertical control were established from existing monumentation on NAVBASE with the horizontal North American Datum 27 and vertical National Geodetic Vertical Datum 29. All traverse closures exceeded 1/20,000. No data corrections were required as part of the monitoring well survey. Soil boring locations were surveyed with the Global Positioning System (GPS).

2.8 Trenching

Trenching with associated soil sampling were conducted near the landfill (SWMU 9) during the summer of 1993. The locations of the trenches were based on targets identified during the geophysical survey and soil-gas investigations described in Appendix E. A clean plastic cover was placed adjacent to each trench location prior to excavation. All excavated material was placed on the plastic to allow all spoils produced during trenching to be returned to the respective trenches or containerized. Each trench was approximately 2 feet wide and extended through less than 1 foot to 3 feet of sandy material into the landfilled waste.

Soil samples were collected from each trench. The samples were taken directly from the contents of the backhoe during excavation and included representative samples of the cover material and soil/waste within the landfill. The backhoe was decontaminated between each trench following the process outlined in Section 2.10.3 of this report. Water produced during the decontamination process was containerized.

The preparation, packaging, shipment, and analysis of the soil samples collected from the trenches were the same as those presented in Section 2.2.3 and 2.2.4 of this report.

All trenching and trench sampling activities were conducted wearing Level B PPE.

2.9 Soil-Gas and Geophysical Surveys

Soil-gas and geophysical surveys were completed during 1992 at two SWMUs in Zone H: SWMU 9, (the closed landfill) and SWMU 14 (the chemical disposal area). The results of these surveys were published in the following report: *Final Technical Memorandum, Preliminary RFI Field Activity Soil-Gas and Geophysics Surveys, SWMUs 9 and 14, Naval Base Charleston, Charleston, South Carolina,* (E/A&H, 1994c) (included as Appendix E). Soil-gas and geophysical surveys were selected and designed to help identify the best locations for follow-up soil sampling, trenching, and groundwater investigations. Survey objectives included a more accurate delineation of the boundaries of the two SWMUs, the identification of buried drums or similar containers, and the identification of detectable leachate plumes.

2.10 Decontamination Procedures

Decontamination procedures were performed in accordance with Section 15 of the CSAP (E/A&H, 1994a) and Appendix B, Section B-8 of the ESDSOPQAM for sampling equipment (USEPA Region IV, 1991) and in accordance with Appendix E, Section E-9 of the ESDSOPQAM for drilling equipment with the following exceptions. The detergent used on this project was Liquinox because it contains powerful chelating agents to bind and remove trace metals from sampling equipment. When available, hot water was used for field decontamination. PVC well construction materials were not solvent-rinsed or washed with hot water. Field reagent grade water was produced onsite to meet the specifications of ASTM Type III water (D 1193-77 re-approved 1983, federal test method 7916). The steam cleaner and/or high-pressure hot water washer were capable of generating adequate pressure and producing hot water and/or steam. All wastes generated during decontamination were containerized in designated drums for disposal by the Navy in accordance with Section 16 of the CSAP.

2.10.1 Decontamination Area Setup

The decontamination area is a concrete pad designed to direct surface runoff into a catch basin. Liquids contained within the catch basin were pumped regularly into designated containers. All equipment was cleaned on saw horses or auger racks above the concrete surface. When field cleaning was necessary, plastic sheeting was placed on the ground to contain any spills.

2.10.2 Cross-Contamination Prevention

The following procedures were implemented during sampling activities to reduce cross-contamination risk.

1. New disposable outer gloves were donned before handling sampling equipment.

2. Only Teflon, glass, or stainless-steel spray bottles/pressurized containers were used to apply decontamination rinsates. Each solution was kept in a separate container.

3. All necessary decontaminated field equipment was transported to the sampling location to minimize the need for field cleaning.

2.10.3 Nonsampling Equipment

Nonsampling equipment includes drill rigs, and backhoes. Nonsampling equipment was decontaminated using the following procedures:

1. Equipment was decontaminated with high-pressure steam.

2. Portions of the equipment contacting material to be sampled were scrubbed with a laboratory-grade detergent and clean water wash solution.

3. Equipment was rinsed with clean water as necessary.

2.10.4 Sampling Equipment

Sampling equipment includes any downhole equipment (e.g., augers, drill pipe, and split-barrel samplers) and any sampling utensils (e.g., stainless-steel spoons, stainless-steel spatulas, stainless-steel bowls, pumps) not dedicated to the sample location. Hollow downhole equipment or equipment with holes potentially transmitting water or drilling fluids was cleaned on the inside and outside. The decontamination procedure was as follows:

1. Protective gloves were donned before decontaminating the equipment.

2. Items were washed and scrubbed with a laboratory-grade detergent and clean water wash solution or decontaminated with high-pressure steam.

3. Items were rinsed with ASTM Type III water.

4. They were next rinsed with organic-free water.

5. Then they were rinsed twice with pesticide-grade isopropyl alcohol.

6. The final rinse was with ASTM Type III water.

7. Equipment was then air dried. If weather prohibited air drying, the isopropyl alcohol rinse was repeated and the item was rinsed with ASTM Type III water twice.

8. Items were wrapped in aluminum foil or plastic sheeting if the sampling equipment was to be stored or transported.

9. Augers and drill rods were covered in clean plastic after decontamination.

3.0 PHYSICAL SETTING

3.1 Geology

3.1.1 Regional Physiographic and Geologic Background

NAVBASE is in the Lower South Carolina Coastal Plain Physiographic Province, on the Cooper River side of the Charleston Peninsula, which is formed by the confluence of the Cooper and Ashley Rivers. Topography in the area is typical of the South Carolina lower coastal plain, having low-relief plains broken only by the meandering courses of sluggish streams and rivers which flow toward the coast past occasional marine terrace escarpments. The topography at NAVBASE is essentially flat. Elevations range from just over 20 feet above mean sea level (msl) in the northwest part of the base to sea level at the Cooper River. Most of the original topography at NAVBASE has been modified by activities such as dredge spoil deposition. The southern end of the base was originally tidal marsh drained by Shipyard Creek and its tributaries. The original elevations in other portions of the base were only slightly higher. The land surface at NAVBASE has been elevated with both solid wastes and dredged materials (primarily the latter) in increments over the last 93 years. Nonetheless, most of NAVBASE remains within the 100-year flood zone of less than 10 feet above msl.

Geology of the Charleston area is typical of the southern Atlantic Coastal Plain. Cretaceous-age and younger sediments thicken seaward and are underlain by older igneous and metamorphic basement rock. Surface exposures at NAVBASE, in the limited areas which remain undisturbed, consist of recent and/or Pleistocene sands, silts, and clays of high organic content referred to as the Wando Formation (Weems and Lemon, 1993). Underlying the Wando Formation, increasing with age, are the Oligocene-age Cooper Group and the Eocene-age Santee Limestone. The Cooper Group is comprised of the Parkers Ferry, Ashley, and Harleyville formations. The formation of particular importance in the Cooper Group is the Ashley Formation, which was formerly referred to as the Cooper Marl in most NAVBASE reports and regional geologic literature. In more recent geologic nomenclature, the name "Cooper" has been given to a group of formations which includes the Ashley Formation, a pale-green to olive-brown, sandy, phosphatic limestone or marl, which is locally muddy and/or sandy. The Ashley Formation in the vicinity of Charleston is encountered at a depth of approximately 30 to 70 feet bgs. The relief of the top of the Ashley Formation is associated with an erosional basin according to Park (1985), who identifies the entire Cooper Unit, which includes the Ashley Formation, as being approximately 300 feet thick.

Surface soil at NAVBASE has been extensively disturbed. Native soil was the fine-grained silts, silty sands, and clay typical of terrigenous tidal marsh environments. Sand lenses are present in localized areas; however, these are generally only a few feet thick. Much of NAVBASE, particularly the southern portion, has been filled using dredged materials from the Cooper River and Shipyard Creek. The dredged materials are an unsorted mixture of sands, silts, and clays. Most of the remainder of the base has been either filled or reworked.

3.1.2 NAVBASE Geologic Investigation

Geological and stratigraphic information has been obtained from soil and monitoring well borings installed during the Zones H and I RFIs. Data for both investigations have been assessed and are included in the geologic and hydrogeologic assessment presented in this RFI report. The soil encountered was classified and logged by an E/A&H geologist as described in Section 2.3. Shelby tubes collected during soil sampling were analyzed for porosity, grain size, and vertical permeability. However, the depth of the deepest borehole limited the information to the upper 80 feet of unconsolidated sediments. Figure 3.1 identifies monitoring wells installed during the Zones H and I RFIs. Table 3.1 summarizes of construction data for all Zone H monitoring wells. Monitoring well construction diagrams and associated lithologic boring logs are included in Appendix B.

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 3.1
MONITORING WELL LOCATION MAP
SOUTHERN PORTION OF NAVAL BASE CHARLESTON

REVISION		
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 003	Rev Date: 12/06/95	Rev By: E. ROGERS
Rev Number: 002	Rev Date: 08/23/95	Rev By: E. ROGERS
Rev Number: 001	Rev Date: 07/18/95	Rev By: E. ROGERS

Dr by: E. ROGERS	Tr by: NAME	
Ck by: B. DOTSON	App by: NAME	Sheet 1
Date: 05/21/95	DWG Name: 29CHZH29	Of 1

0037bBBR02X

Table 3.1
Zone H Monitoring Well Construction Data Summary

Monitoring Well ID #	Ground Surface Elevation	Date Installed	Total Depth (ft)	Screened Interval	Top of Casing (TOC) Elevation	Depth to Groundwater• (below TOC)
NBCH009001	6.9	9/24/93	14.0	4-14	9.68	6.13
NBCH009002	7.9	9/27/93	15.0	5-15	10.89	6.45
NBCH009003	7.6	9/27/93	12.0	2-12	10.42	5.38
NBCH009004	4.0	9/28/93	13.75	3.75-13.75	7.15	4.26
NBCH009005	6.2	9/28/93	13.0	3-13	9.16	3.80
NBCH009006	9.8	9/29/93	15.0	5-15	12.61	8.77
NBCH009007	5.1	9/29/93	13.5	3.5-13.5	7.91	4.70
NBCH009008	5.6	10/4/93	14.0	4-14	8.44	4.50
NBCH009009	11.3	10/4/93	14.75	4.75-14.75	14.27	8.85
NBCH009010	8.2	10/5/93	15.0	5-15	11.25	5.60
NBCH009011	10.7	10/5/93	14.75	4.75-14.75	13.77	7.53
NBCH009012	7.1	10/25/94	15.0	3-13	9.62	5.62
NBCH009013	6.5	10/25/94	15.0	3-13	8.99	6.75
NBCH009014	6.4	10/25/94	15.0	3-13	8.84	5.72
NBCH009015	8.2	10/26/94	15.0	3-13	10.72	7.77
NBCH009016	5.6	4/11/95	15.0	4-14	10.93	5.01
NBCH009017	5.5	4/11/95	13.0	2-12	8.38	5.16
NBCH009018	5.0	4/11/95	15.0	4-14	7.99	4.54
NBCH009019	5.7	4/11/95	13.0	2-12	8.46	4.82
NBCH009121	6.7	10/24/94	15.0	3-13	9.15	3.68
NBCH00902D	8.1	10/10/94	55.0	44-54	10.80	5.04
NBCH00903D	7.4	8/26/94	50.0	38-49	9.88	0.76
NBCH00904D	4.4	10/18/94	45.0	25-35	7.19	4.61

Table 3.1
Zone H Monitoring Well Construction Data Summary

Monitoring Well ID #	Ground Surface Elevation	Date Installed	Total Depth (ft)	Screened Interval	Top of Casing (TOC) Elevation	Depth to Groundwater• (below TOC)
NBCH00905D	8.3	10/14/94	65.0	50-60	10.83	0.80
NBCH00906D	10.8	10/17/94	55.0	25-35	13.20	9.11
NBCH00907D	4.8	9/20/94	75.0	60-70	7.73	5.13
NBCH00908D	5.3	10/15/94	55.0	43-53	7.85	0.61
NBCH00912D	6.9	10/22/94	70.0	57-67	9.42	6.54
NBCH013001	8.2	8/29/94	13.0	3-13	10.78	7.13
NBCH013002	7.2	8/29/94	15.0	4-14	9.12	5.15
NBCH013003	8.2	8/29/94	15.0	4-14	10.17	7.14
NBCH013004	8.9	8/30/94	17.0	7-17	11.27	6.73
NBCH013005	9.0	9/6/94	15.0	4-14	11.47	7.68
NBCH013006	8.8	9/6/94	15.0	4-14	8.61	5.10
NBCH013007	8.7	9/12/94	14.0	3-13	8.45	4.32
NBCH017001	11.6	9/7/94	13.0	3-13	11.45	5.99
NBCH017002	10.6	9/8/94	13.0	3-13	10.47	4.66
NBCH017003	11.5	9/8/94	15.0	4-14	11.39	4.29
NBCH017004	10.2	9/10/94	14.0	3-13	9.80	3.25
NBCH017005	10.5	4/7/95	15.0	2-12	10.29	4.42
NBCH017006	10.4	4/7/95	12.8	2-12	10.26	4.24
NBCH136001	9.5	9/21/94	13.0	2-12	9.12	3.48
NBCH178001	9.9	9/13/94	13.0	2-12	12.23	5.89
NBCH178002	9.4	9/14/94	13.0	2-12	9.16	3.12
NBCH653001	6.3	9/12/94	15.0	3-13	6.10	2.26
NBCH653002	6.4	9/12/94	15.0	3-13	6.26	2.92

Table 3.1
Zone H Monitoring Well Construction Data Summary

Monitoring Well ID #	Ground Surface Elevation	Date Installed	Total Depth (ft)	Screened Interval	Top of Casing (TOC) Elevation	Depth to Groundwater[a] (below TOC)
NBCH655001	9.6	9/13/94	15.0	4-14	9.46	3.99
NBCH655002	8.7	8/29/94	15.0	3-13	8.82	2.46
NBCH655003	8.9	9/13/94	15.0	3-13	8.80	2.58
NBCH656001	9.1	8/25/94	15.0	3.5-13.5	11.23	4.32
NBCH656002	8.5	8/25/94	15.0	4-14	10.77	4.86
NBCH656003	8.5	8/25/94	15.0	5-15	10.94	NA
NBCH660001	9.2	9/8/94	15.0	3-13	8.95	4.90
NBCH660002	8.8	9/9/94	15.0	3-13	8.59	4.71
NBCH662001	8.8	9/7/94	15.0	2-12	8.62	4.43
NBCH662002	9.4	9/7/94	15.0	3-13	9.16	5.40
NBCH663001	8.7	8/27/94	12.0	2.5-12.5	11.31	4.70
NBCH663002	8.2	9/21/94	13.0	2-12	7.92	1.42
NBCH666001	8.2	9/9/94	15.0	4-14	10.59	8.68
NBCH666002	8.6	9/9/94	15.0	3-13	10.86	6.49
NBCH667001	7.1	9/12/94	15.0	4-14	6.92	4.72
NBCH667002	7.0	9/12/94	15.0	4-14	6.74	3.48
NBCH014001	10.4	9/22/94	13.0	3-13	12.92	7.90
NBCH014002	10.5	9/22/94	13.0	3-13	13.23	8.54
NBCH014003	8.4	9/23/94	13.0	3-13	10.99	6.74
NBCH014004	7.1	9/23/94	13.0	3-13	9.72	6.12
NBCH014005	9.4	9/23/94	13.0	3-13	11.90	7.13
NBCH01401D	10.2	10/20/94	55.0	36-46	12.58	7.63
NBCH01402D	10.6	10/20/94	45.0	35-45	12.87	7.59

Table 3.1
Zone H Monitoring Well Construction Data Summary

Monitoring Well ID #	Ground Surface Elevation	Date Installed	Total Depth (ft)	Screened Interval	Top of Casing (TOC) Elevation	Depth to Groundwater* (below TOC)
NBCH01403D	8.7	10/20/94	45.0	35-45	11.24	7.08
NBCH01404D	6.8	10/21/94	45.0	25-35	9.38	6.55
NBCH01405D	9.2	10/21/94	45.0	21-31	11.65	7.66
NBCHGDH001	10.4	9/26/94	15.0	3-12	13.01	7.79
NBCHGDH002	7.2	9/26/94	15.0	5-15	9.82	3.90
NBCHGDH003	10.6	9/27/94	13.0	3-13	13.20	9.35
NBCHGDH004	9.0	9/27/94	13.0	3-13	11.83	8.52
NBCHGDH005	11.9	9/27/94	14.0	3-13	14.73	8.99
NBCHGDH006	7.8	9/28/94	13.0	3-13	7.59	4.41
NBCHGDH007	9.2	9/28/94	14.0	4-14	12.22	8.42
NBCHGDH008	9.8	9/28/94	13.0	3-13	12.94	7.02
NBCHGDH009	10.5	10/3/94	15.0	5-15	12.78	8.67
NBCHGDH010	7.3	10/3/94	13.0	2-12	9.26	5.92
NBCHGDH011	6.9	10/4/94	13.0	2-12	9.60	5.73
NBCHGDH01D	10.3	10/3/94	70.0	51-61	13.06	7.63
NBCHGDH02D	7.2	10/11/94	65.0	50-60	9.83	7.60
NBCHGDH03D	10.4	10/12/94	45.0	35-45	12.85	7.07
NBCHGDH04D	9.1	10/19/94	65.0	53-63	11.72	6.56
NBCHGDH05D	11.7	10/19/94	65.0	53-63	14.35	7.67
NBCHGDH06D	7.8	10/18/94	45.0	33-43	7.70	5.90
NBCHGDH07D	9.3	10/22/94	46.0	33-43	11.85	9.64
NBCHGDH08D	10.3	10/19/94	45.0	35-45	13.10	7.96
NBCHGDH09D	10.9	10/21/94	60.0	43-53	13.29	6.75

Table 3.1
Zone H Monitoring Well Construction Data Summary

Monitoring Well ID #	Ground Surface Elevation	Date Installed	Total Depth (ft)	Screened Interval	Top of Casing (TOC) Elevation	Depth to Groundwater[a] (below TOC)
NBCHGDH10D	7.3	10/15/94	65.0	55-65	9.59	4.98
NBCHGDH11D	7.0	10/14/94	65.0	48-58	9.55	1.44
Temporary Monitoring Well and Hydropunch Construction Data						
020HP01	NS	9/19/94	65.0	NA	NA	NA
020HP02	NS	9/21/94	50.0	NA	NA	NA
020HP03	NS	9/21/94	40.0	NA	NA	NA
020HP04	NS	9/22/94	40.0	NA	NA	NA
020HP05	NS	9/22/94	60.0	NA	NA	NA
020TW02	7.9	10/4/94	14.5	4.5-14.5	NA	NA
020TW03	6.5	10/5/94	12.0	2-12	NA	NA
020TW04	6.6	10/5/94	12.0	2-12	NA	NA
020TW05	4.1	10/7/94	54.0	0-5	NA	NA
020TW06	7.6	10/4/94	12.0	2-12	NA	NA
020TW07	5.5	10/5/94	12.0	2-12	NA	NA
020TW08	5.4	10/7/94	12.0	2-12	NA	NA
020TW09	13.6	10/6/94	15.0	5-15	NA	NA
020TW10	11.7	10/6/94	15.0	5-15	NA	NA
020TW11	11.1	10/6/94	15.0	5-15	NA	NA
020TW12	9.5	10/7/94	15.0	5-15	NA	NA
121TW01	6.7	10/5/94	12.0	2-12	NA	NA
121TW02	4.8	10/5/94	12.0	2-12	NA	NA
121TW03	6.7	10/8/94	12.0	2-12	NA	NA
121TW04	6.0	10/6/94	12.0	2-12	NA	NA

Table 3.1
Zone H Monitoring Well Construction Data Summary

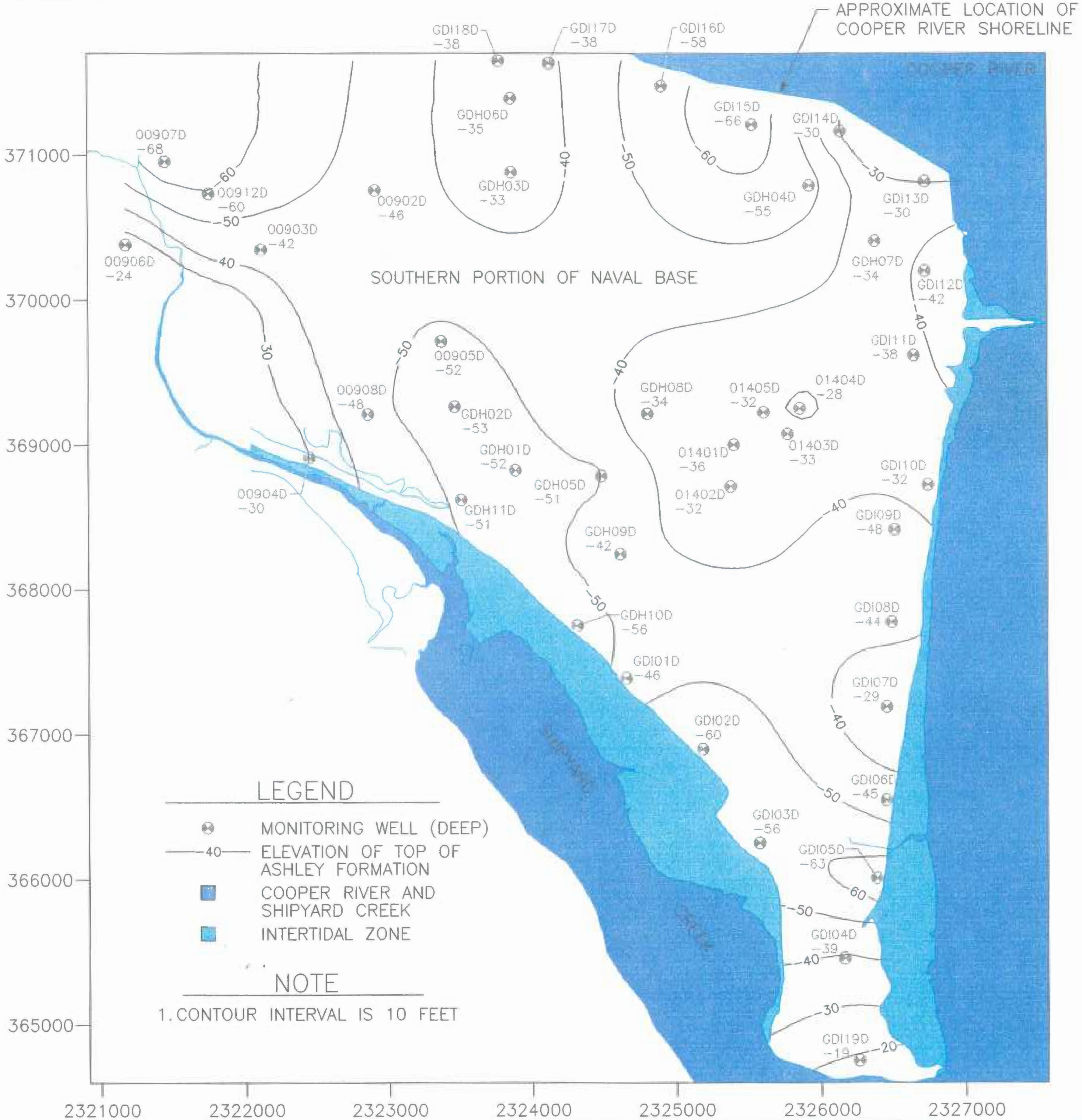
Monitoring Well ID #	Ground Surface Elevation	Date Installed	Total Depth (ft)	Screened Interval	Top of Casing (TOC) Elevation	Depth to Groundwater[a] (below TOC)
Temporary Monitoring Well and Hydropunch Construction Data						
121TW05	7.8	10/7/94	12.0	2-12	NA	NA

Notes:
a = Depth to groundwater varies by season and time of day. Depths to water presented in this table should only be considered approximate.
NA = Not Available
NS = Not Surveyed

Of the stratigraphic formations described in Section 3.1.1, only two (the Wando and Ashley formations) were encountered during the Zone H RFI. The lowermost stratigraphic unit identified is the Ashley Formation of the Oligocene-age Cooper Group. Figure 3.2 is a contour map of the erosional surface of the Ashley Formation. Above the Ashley lies what is believed to be sediments of the Quaternary-age Wando Formation. Lithologic cross sections prepared with data collected during monitoring well installation are presented in Figures 3.3, 3.4, and 3.5, which the following discussion of the geology of NAVBASE is based.

3.1.3 Ashley Formation

The Ashley Formation is an olive-yellow to olive-brown, tight, calcareous, sandy and clayey silt often found dry in split-spoon samples. The top of this formation, which was encountered at depths ranging from 35 to 77 feet bgs, represents the target depth of the deep borings.



N

Coordinates X	Coordinates Y	Well	Ground Surface (Elevation)	Top of Ashley Formation (Elevation*)
2322906	370757.3	00902D	8.10	-46
2322115	370349.0	00903D	7.40	-42
2322446	368913.3	00904D	4.40	-30
2323367	369716.2	00905D	8.30	-52
2321179	370382.5	00906D	10.80	-24
2321454	370954.8	00907D	4.80	-68
2322854	369212.9	00908D	5.30	-48
2321754	370734.7	00912D	6.90	-60
2325395	369001.7	01401D	10.20	-36
2325376	368713.4	01402D	10.60	-32
2325767	369076.1	01403D	8.70	-33
2325851	369251.7	01404D	6.80	-28
2325602	369226.0	01405D	9.20	-32
2323884	368825.5	GDH01D	10.30	-52
2323459	369264.9	GDH02D	7.20	-53
2323859	370881.2	GDH03D	10.40	-33
2325921	370788.3	GDH04D	9.10	-55
2324482	368786.6	GDH05D	11.70	-51
2323855	371388.8	GDH06D	7.80	-35
2326375	370408.5	GDH07D	9.30	-34
2324801	369216.7	GDH08D	10.30	-34
2324613	368247.2	GDH09D	10.90	-42
2324315	367752.3	GDH10D	7.30	-56
2323504	368621.9	GDH11D	7.00	-51
2324655	367390.1	GDI01D	6.37	-46
2325181	366899.3	GDI02D	9.27	-60
2325573	366253.2	GDI03D	6.28	-56
2326159	365457.7	GDI04D	6.11	-39
2326384	366008.5	GDI05D	4.02	-63
2326452	366548.3	GDI06D	5.11	-45
2326455	367191.8	GDI07D	7.96	-29
2326489	367775.8	GDI08D	9.00	-44
2326511	368414.3	GDI09D	8.69	-48
2326744	368723.6	GDI10D	5.19	-32
2326645	369617.0	GDI11D	6.20	-38
2326724	370200.1	GDI12D	8.20	-42
2326726	370816.4	GDI13D	9.23	-30
2326139	371163.7	GDI14D	8.91	-30
2325526	371208.6	GDI15D	8.25	-66
2324901	371473.9	GDI16D	6.11	-58
2324125	371632.2	GDI17D	7.61	-38
2323771	371647.2	GDI18D	7.24	-38
2326259	364751.3	GDI19D	6.31	-19

* Feet below mean sea level

800 0 800
SCALE FEET

ZONE H
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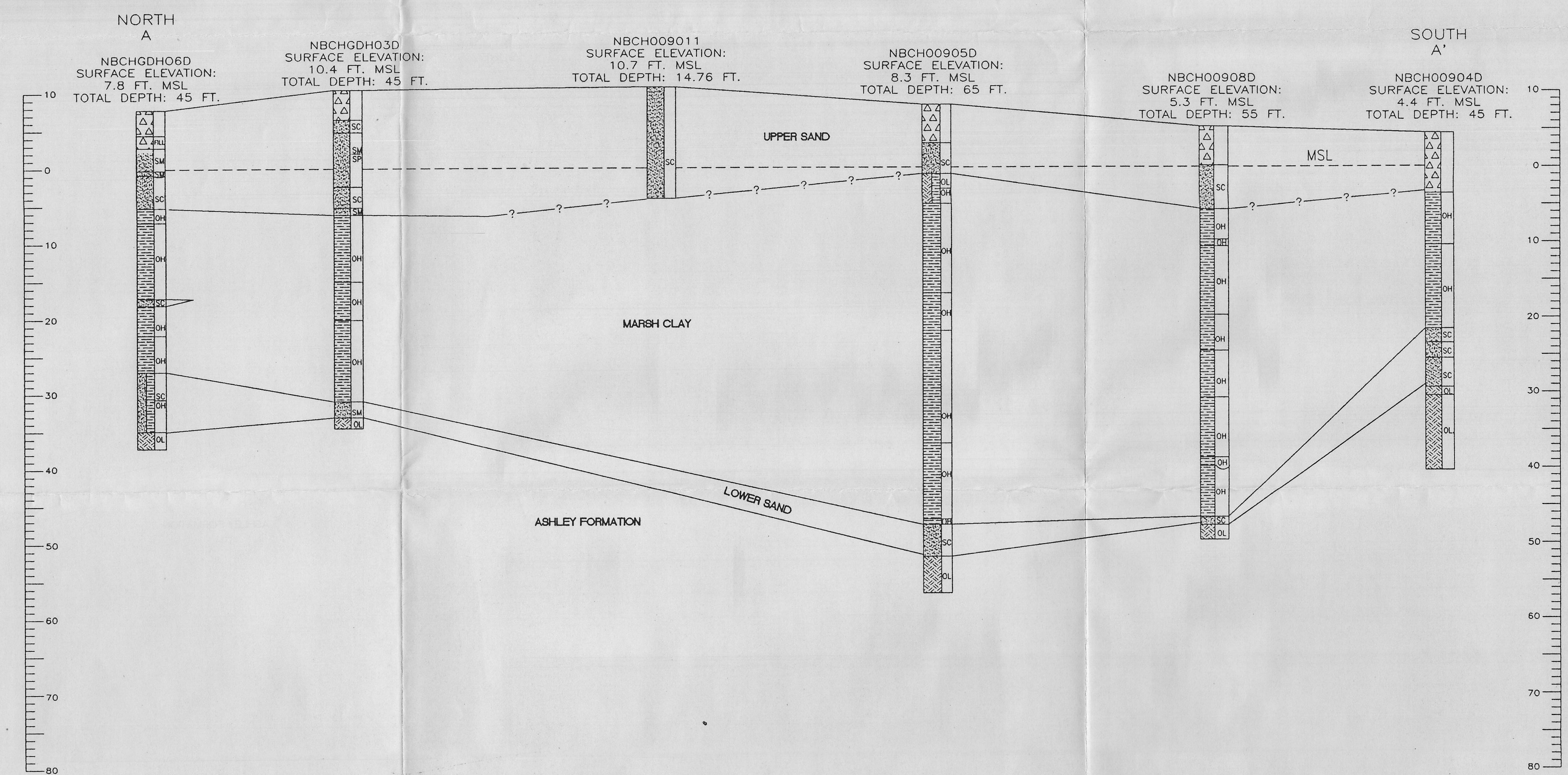
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA

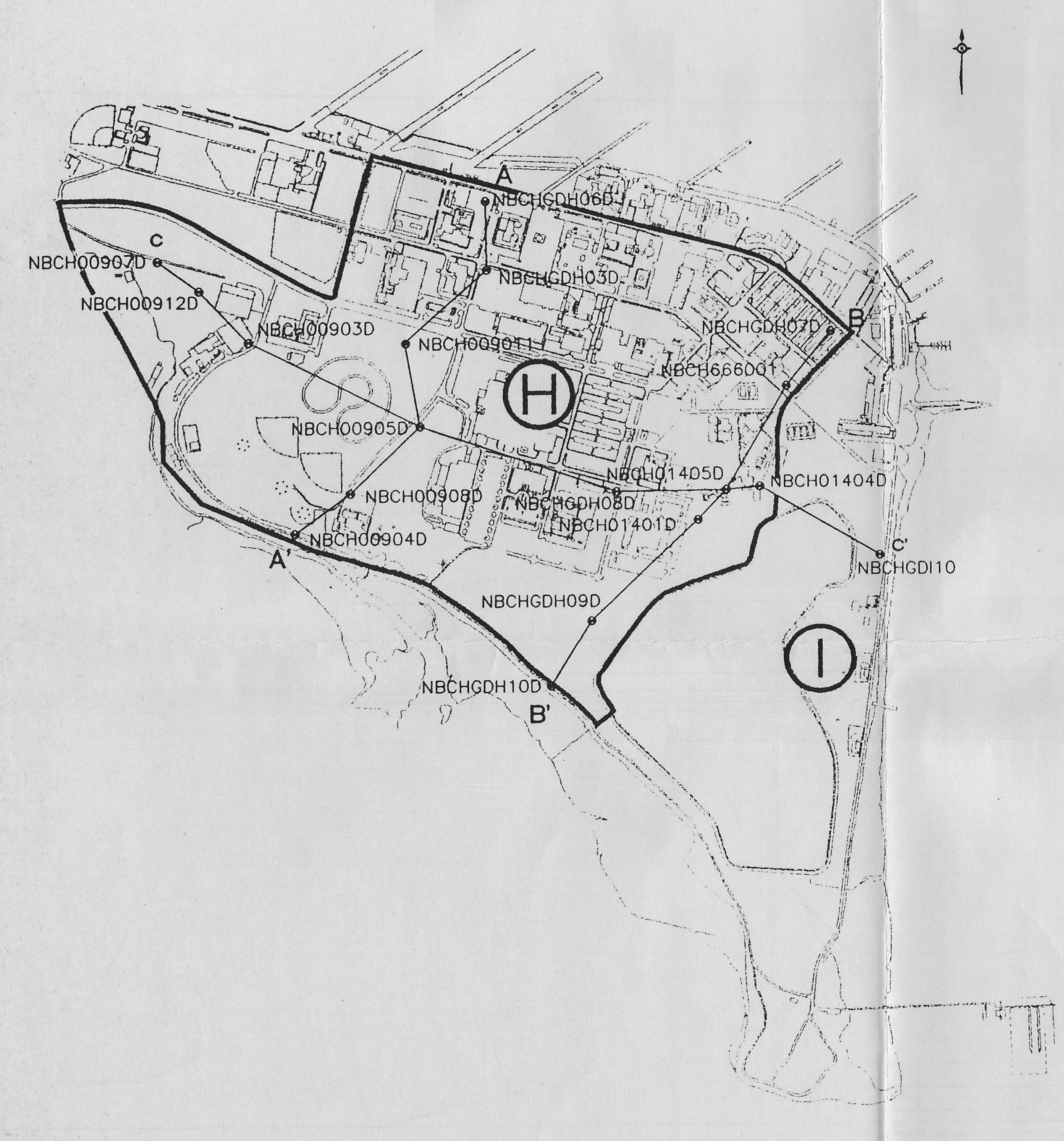
FIGURE 3.2
PALEOGEOLOGIC CONTOUR MAP FOR TOP OF ASHLEY FORMATION

DWG DATE: 12/07/95 | DWG NAME: 29CHZH33

00376 BBB 032



CROSS SECTION LOCATION MAP



LEGEND

UNIFIED SOIL CLASSIFICATION SYSTEM	DESCRIPTION	
SC, SM, SP	SANDS:	DARK GRAY TO OLIVE GRAY SANDS. RANGING FROM FINE TO COARSE WITH LITTLE TO NO FINES. CONTAINS VARYING AMOUNTS OF SHELL FRAGMENTS. LOWER UNIT IS HIGH IN SHELL CONTENT. **AQUIFER**
OH, CL, ML	MARSH CLAY:	SILTY CLAY TO CLAY. DARK BROWN TO OLIVE BLACK CONTAINING PLANT DETRITUS, OYSTER SHELLS, VARYING AMOUNTS OF SHELL FRAGMENTS AND THIN LENSES OF SAND. **AQUITARD**
OL	ASHLEY FORMATION:	MUSTARD YELLOW TO OLIVE BROWN. CLAY WITH SILT. UNCONSOLIDATED BUT STIFF. **CONFINING UNIT**
FILL		

200 0 200
SCALE FEET

VERTICAL: 1" = 10'

REVISION		
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME

ZONE H
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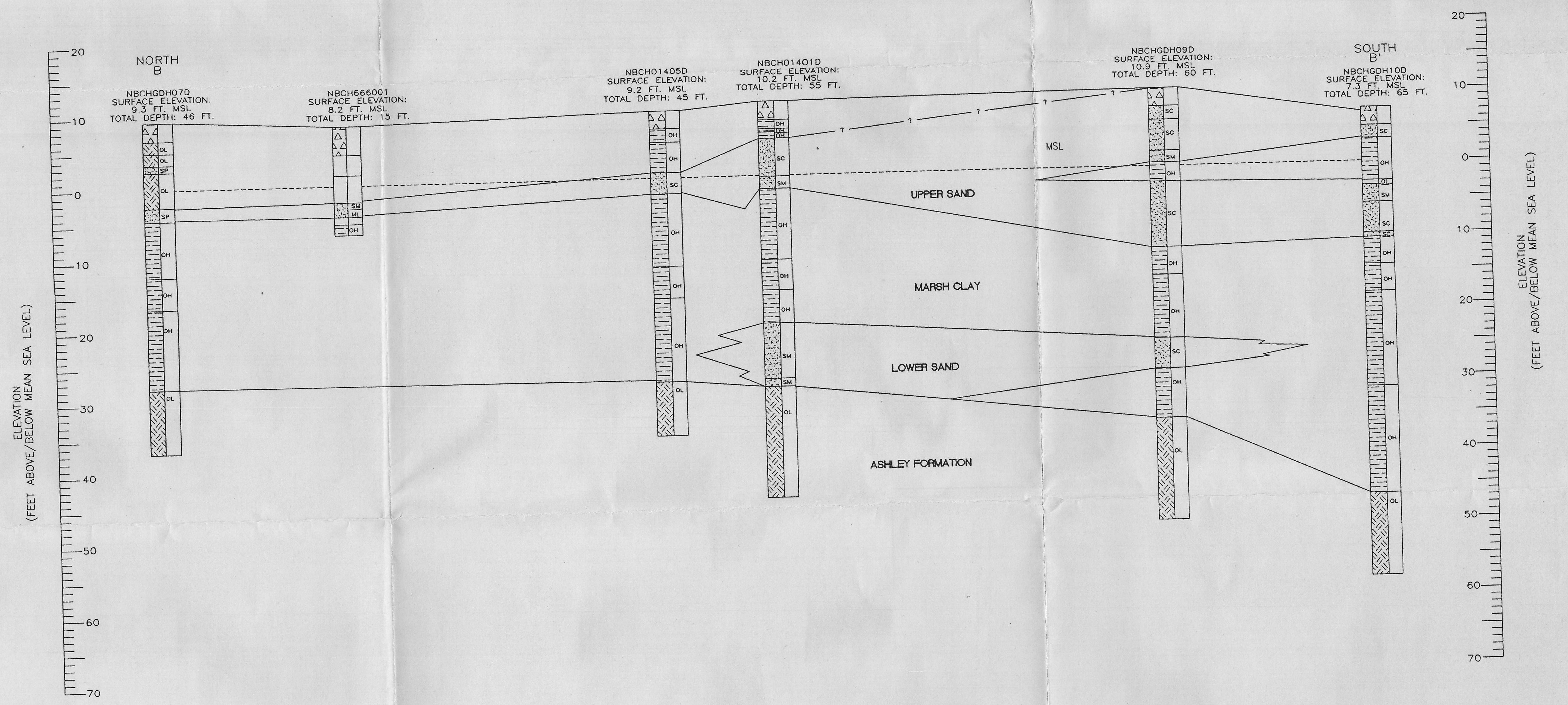
NAVAL BASE CHARLESTON
CHARLESTON, SC

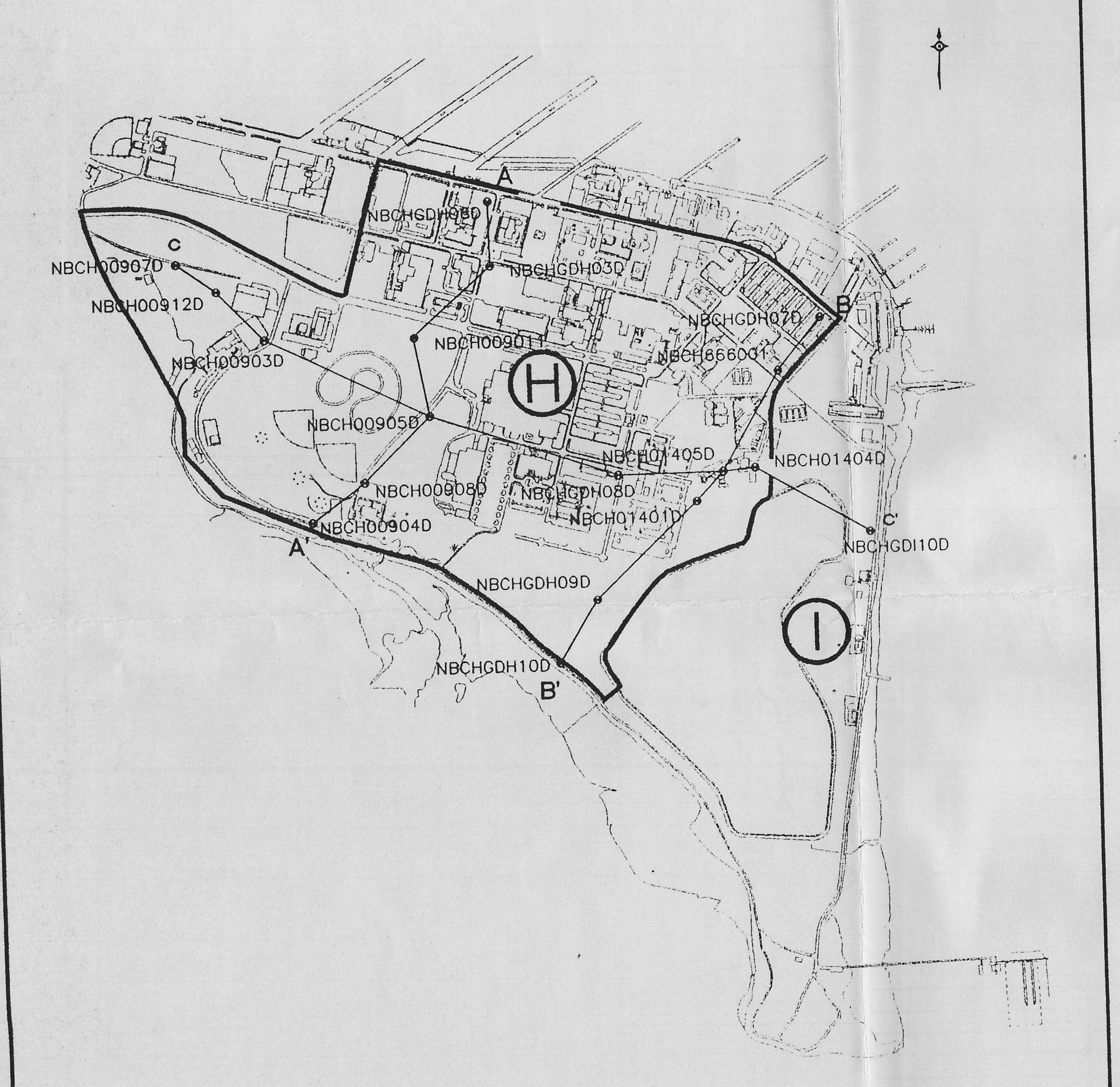
FIGURE 3.3
NAVBASE CHARLESTON
LITHOLOGIC CROSS SECTION A–A'

Dr by: C. GIAROLI	Tr by: E. ROGERS	
Ck by: J. HARDY	App by: B. DOTSON	Sheet 1
Date: 12/21/95	DWG Name: 29CHZH39	Of 1

00376BBB B4X



CROSS SECTION LOCATION MAP



LEGEND

UNIFIED SOIL CLASSIFICATION SYSTEM	DESCRIPTION	
SC, SM, SP	SANDS:	DARK GRAY TO OLIVE GRAY SANDS. RANGING FROM FINE TO COARSE WITH LITTLE TO NO FINES. CONTAINS VARYING AMOUNTS OF SHELL FRAGMENTS. LOWER UNIT IS HIGH IN SHELL CONTENT. **AQUIFER**
OH, CL, ML	MARSH CLAY:	SILTY CLAY TO CLAY. DARK BROWN TO OLIVE BLACK CONTAINING PLANT DETRITUS, OYSTER SHELLS,VARYING AMOUNTS OF SHELL FRAGMENTS AND THIN LENSES OF SAND. **AQUITARD**
OL	ASHLEY FORMATION:	MUSTARD YELLOW TO OLIVE BROWN. CLAY WITH SILT. UNCONSOLIDATED BUT STIFF. **CONFINING UNIT**
FILL		

200 0 200
SCALE FEET

VERTICAL: 1" = 10'

REVISION		
Rev Number: 000	Rev Date:00/00/00	Rev By: NAME
Rev Number: 000	Rev Date:00/00/00	Rev By: NAME
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Rev Number: 000	Rev Date:00/00/00	Rev By: NAME
Rev Number: 000	Rev Date:00/00/00	Rev By: NAME

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 3.4
NAVBASE CHARLESTON
LITHOLOGIC CROSS SECTION B–B'

Dr by: C. GIAROLI	Tr by: E. ROGERS	
Ck by: J. HARDY	App by: B. DOTSON	Sheet 1
Date: 12/21/95	DWG Name: 29CHZH38	Of 1

CROSS SECTION LOCATION MAP

LEGEND

UNIFIED SOIL CLASSIFICATION SYSTEM	DESCRIPTION	
SC, SM, SP	SANDS:	DARK GRAY TO OLIVE GRAY SANDS. RANGING FROM FINE TO COARSE WITH LITTLE TO NO FINES. CONTAINS VARYING AMOUNTS OF SHELL FRAGMENTS. LOWER UNIT IS HIGH IN SHELL CONTENT. **AQUIFER**
OH, CL, ML	MARSH CLAY:	SILTY CLAY TO CLAY. DARK BROWN TO OLIVE BLACK CONTAINING PLANT DETRITUS, OYSTER SHELLS,VARYING AMOUNTS OF SHELL FRAGMENTS AND THIN LENSES OF SAND. **AQUITARD**
OL	ASHLEY FORMATION:	MUSTARD YELLOW TO OLIVE BROWN. CLAY WITH SILT. UNCONSOLIDATED BUT STIFF. **CONFINING UNIT**
FILL		

200 0 200
FEET
VERTICAL: 1' = 10'

REVISION		
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 001	Rev Date: 07/18/95	Rev By: E. ROGERS

ZONE H
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INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 3.5
NAVBASE CHARLESTON
LITHOLOGIC CROSS SECTION C–C'

Dr by: C. GIAROLI	Tr by: E. ROGERS	
Ck by: J. HARDY	App by: B. DOTSON	Sheet 1
Date: 12/21/95	DWG Name: 29CHZH37	Of 1

Five Shelby tube samples collected from the Ashley Formation exhibited an average porosity of 54%. The grain size and hydrometer analyses indicated that the average silt content was 49%, sand content was 27%, and clay averaged 27% in the five samples. Geotechnical information from the Shelby tube samples is presented in Appendix F.

Figure 3.2 is a paleogeologic map depicting the former erosional surface of the Ashley Formation. The map indicates that relief on the surface of the Ashley is considerably greater than the topographic relief at ground surface. Maximum relief of the top of the Ashley Formation is 49 feet measured between the highest point at deep well location NBCIGDI19D (-19 feet msl) and the lowest point at deep well location NBCH00907D (-68 feet msl). Erosional surface lows on the Ashley occur at NBCH00907D, NBCIGDI15D, and along a northwest/southeast trending line from NBCH00905D to NBCIGDI05D.

3.1.4 Wando Formation

Overlying the Ashley and extending to ground surface (in areas not covered by dredged materials) is the Wando Formation, which ranges from approximately 35 to 77 feet thick. The Wando is made up of one or more horizon(s) of undifferentiated sand and clay which vary greatly in thickness and distribution. Beneath most of the site the Wando has a lower sand layer overlain by a "marsh clay" layer. Another surficial sand layer generally overlies this clay unit. However, at some borehole locations, either sand layer may be absent or additional clay layers may be present above the upper sand and below the lower sand layers.

The lower sand, characteristically gray-green or gray-brown, medium- to well-sorted, and clayey, often contains shell fragments and phosphate nodules. The maximum thickness of this sand was 14 feet as measured in borehole NBCH00912D. The average porosity of four Shelby tube samples collected from the lower sand was 69 percent. The grain-size distributions for these samples averaged 36% silt, 27% sand, and 37% clay.

The lower sand is overlain by a grayish-green and blackish-green, sandy, fat (high plasticity), silty-clay that often contains shell-hash layers and plant remains. Also referred to as "marsh clay," this unit characteristically has a high organic content which results in a distinct hydrogen sulfide (H_2S) odor. The average porosity of four Shelby tube samples collected from the lower sand was 69%. The grain-size distributions for these samples averaged 36% silt, 27% sand, and 37% clay.

The top of the Wando is usually represented by a surficial sand layer that overlies the marsh-clay. This grayish-green to olive-tan clayey sand is fine- to coarse-grained and also often contains shell-hash layers and phosphate nodules. Physical analysis of this sand indicated an average porosity of 37%, and a grain-size distribution of 5% silt, 88% sand, and 7% clay.

Although most of the site is underlain with the stratigraphy described above, isolated areas do not fit this simplified stratigraphy. For example, to the northeast, between boreholes NBCHGDH07D and NBCH01405D, the lower sand is absent and a layer of marsh clay lies above the upper sand layer. The same sequence occurs at NBCH00903D and NBCHGDH10D. To the west, the upper sand layer is absent at NBCH00907D and NBCH00912D and the lower sand layer is underlain by marsh clay at NBCH00912D.

3.1.5 Fill Deposits

In many areas across the southern portion of NAVBASE Charleston, the Wando Formation is overlain by fill material used to raise the elevation of low-lying areas, extend shorelines, and protect riverbanks and shorelines from tidal erosion. These fill deposits consist of dredged materials from the Cooper River and Shipyard Creek; domestic, industrial, and medical wastes (primarily in the area of SWMU 9); and former quay-wall construction materials such as large rock boulders, slabs of concrete, wood pilings, and crushed rock and gravel.

3.2 NAVBASE Hydrogeology

3.2.1 Regional Hydrologic and Hydrogeologic Background

Parts of the southern portion of NAVBASE are drained by Shipyard Creek while some northern areas are drained by Noisette Creek. The drainage basins of both waterways include areas other than NAVBASE. These waterways are tributaries of the Cooper River. Surface drainage over the remainder of NAVBASE flows directly into the Cooper River, which discharges into Charleston Harbor.

Shipyard Creek, a small tidal tributary about two miles long, flows southeast along the southwestern boundary of NAVBASE to its confluence with the Cooper River opposite the southern tip of Daniel Island. Docks are along the western shore of the lower mile of the channel, while the entire length of the eastern shore is bounded by tidal marshland.

Noisette Creek, which transects the northern portion of NAVBASE, is a tidal tributary approximately 2.5 miles long. The creek flows nearly due east from its headwaters in the City of North Charleston and empties into the Cooper River.

Groundwater occurs under water table or poorly confined conditions within the Pleistocene deposits overlying the Ashley Formation of the Cooper Group. Transmissivities in the Pleistocene aquifer are generally less than 1,000 feet per day and well yields are variable, ranging from 0 to 200 gallons per minute (gpm). This groundwater contains high concentrations of iron and is commonly acidic at shallow depths (Park, 1985).

The Cooper Group is hydrogeologically significant mainly because of its low permeability. In most locales, its sandy, finely granular limestones produce little or no water, but instead act as confining material that causes artesian conditions in the underlying Santee Limestone.

The Santee Limestone aquifer, which underlies the Cooper Group, is typically artesian, except in outcrop areas. Yields from wells in the Santee are typically less than 300 gpm (Park, 1985).

3.2.2 NAVBASE Hydrogeologic Investigation

Hydrogeological information was obtained from slug test analysis, water level measurements, and tidal influence monitoring conducted during the Zone H RFI. Estimates of vertical permeability, grain-size distribution, and porosity were obtained from analysis of Shelby tube samples collected during drilling.

3.2.3 Lower Confining Unit

The high clay and silt content, laterally consistent overall thickness, and very low vertical permeabilities of the Ashley Formation strongly suggest that this formation serves as an aquitard beneath Zone H. The five Shelby tube samples collected from the Ashley exhibited a very low average vertical hydraulic conductivity of 0.0027 feet per day. According to Fetter (1988), sediments with permeabilities of 0.03 feet/day or less can be considered confining units. The low vertical permeability found in the Ashley indicates an extremely low potential for groundwater movement through the unit. The fact that many of the soil samples collected from this formation were dry lends further credence to its designation as an aquitard. As an aquitard, the Ashley serves as a lower confining unit to the water-bearing sediments of the overlying Wando Formation.

3.2.4 Shallow Aquifer

The two sand layers of the Wando Formation are distinct water-bearing zones that exhibit limited hydraulic connection. Beneath much of the site, the "marsh mud" clay layer serves as an aquitard separating the upper and lower sands.

The lower sand is considered semiconfined to confined by the intervening clay layer because water levels in wells screened across the lower sand rise well above the top of the unit. Generally, potentiometric head levels in this unit are within 10 feet of ground surface and in some wells (NBCH00903D, NBCH00905D, NBCH00908D, and NBCHGDH05D) the potentiometric head level is above ground surface.

The high silt and clay content of the marsh-clay layer makes it a viable aquitard that impedes flow between the sands. The four Shelby tube samples collected from this unit had an average vertical hydraulic conductivity of 0.001 feet/day, 2.7 times lower than that of the Ashley Formation.

The upper sand is considered unconfined. However, it may be semiconfined where it is overlain by marsh clay or silty-clay fill material. Water levels in the upper sand are usually within 6 feet of ground surface, and at, well NBCH009005, groundwater is above ground surface.

3.2.5 Groundwater Flow Direction

The potentiometric surface maps for the upper and lower zones of the shallow aquifer are presented as Figures 3.6 and 3.7. Figure 3.6 incorporates data from the shallow wells and generally represents the upper sand aquifer because most of the shallow wells were screened in that unit. For the same reason, Figure 3.7 roughly depicts the potentiometric surface of the lower sand.

Figure 3.6 (upper sand) shows that much of the central and southeastern portions of NAVBASE contain areas of high groundwater elevation that roughly form a groundwater ridge or divide trending northwest/southeast. Groundwater to the north and east of this ridge flows toward the Cooper River while groundwater to the southwest flows toward Shipyard Creek.

Figure 3.7 (lower sand) displays a large area of high groundwater potential covering the northeastern and most of the central portions of the southern end of NAVBASE. Southwest of this area, groundwater in the lower sand flows toward Shipyard Creek. Groundwater to the north, east, and southeast of this potentiometric surface high flows toward the Cooper River.

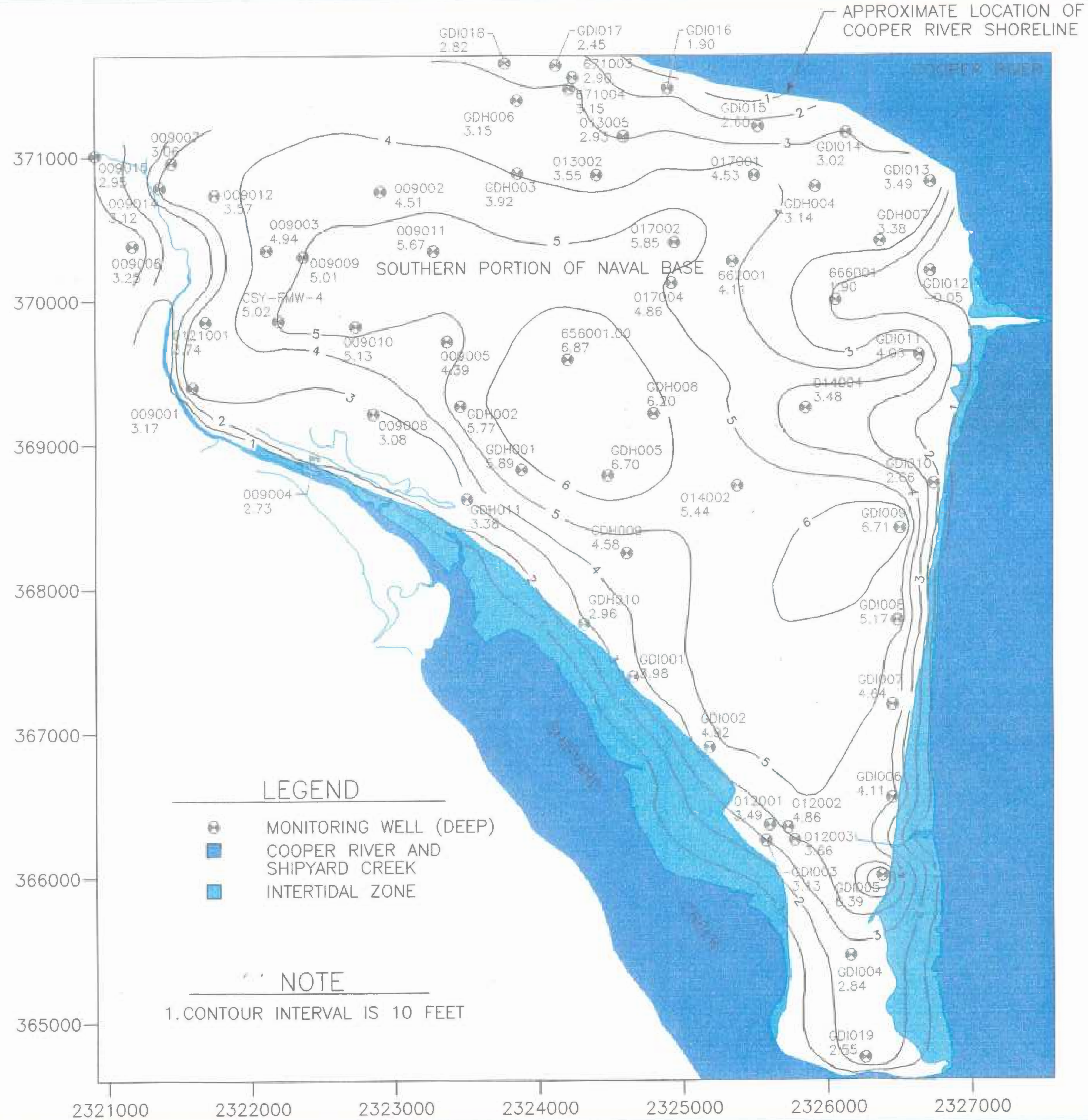
3.2.6 Vertical Hydraulic Gradient

When water levels at shallow/deep well pairs on the southern portion of NAVBASE are compared, there is usually a downward hydraulic gradient between the two sand layers. However, at some of the well pairs, water levels are either the same or there is a distinct upward hydraulic gradient between the layers.

Table 3.2 presents the calculated vertical hydraulic gradients between each of the shallow/deep well pairs. The vertical gradients were calculated by dividing the difference in static water-level elevation by the vertical distance between each aquifer at each well pair. In cases where either (or both) sand layer was not present, the vertical distance between well screens was used in the calculation (Bedient, et. al. 1994). Figure 3.8 presents the distribution of vertical gradients across the site. Positive gradients indicate a downward potential for vertical flow and negative gradients indicate potential for upward flow.

Most of the well pairs have a downward hydraulic gradient (positive) indicating the potential for groundwater to flow from the upper sand aquifer to the lower sand aquifer. This does not necessarily mean that the aquifers are hydraulically connected beneath the site. It does indicate the direction of flow if a connection exists. However, no connection between the upper and lower sands was observed in any of the Zone H boreholes. At some lateral distance from Zone H, a connection between the two sands could exist in association with the Cooper River and/or Shipyard Creek.

Well pairs that exhibit negative vertical gradients indicate a potential for upward vertical flow between the lower and upper sands. Most of the well pairs with upward vertical flow potential are along the southwestern shore of the peninsula near Shipyard Creek. This area roughly corresponds with one of the erosional surface lows indicated on the paleogeologic map of the Ashley Formation (Figure 3.2).



Coordinates X	Y	Well	Top of Casing Elevation	Depth to Groundwater (5/11/95)	Groundwater Elevation
2322180	369859.1	CSY-FMW-4	8.05	3.03	5.02
2321585	369398.0	009001	9.68	6.51	3.17
2322898	370759.8	009002	10.89	6.38	4.51
2322112	370341.4	009003	10.42	5.48	4.94
2322451	368919.5	009004	7.10	4.37	2.73
2323331	369705.6	009005	9.16	4.77	4.39
2321174	370378.8	009006	12.61	9.36	3.25
2321459	370945.9	009007	7.91	4.85	3.06
2322861	369251.5	009008	8.44	5.36	3.08
2322353	370304.8	009009	14.27	9.26	5.01
2322720	369818.8	009010	11.25	6.12	5.13
2323258	370342.3	009011	13.77	8.10	5.67
2321753	370727.7	009012	9.62	6.05	3.57
2321358	370786.1	009014	8.84	5.72	3.12
2320901	371010.5	009015	10.72	7.77	2.95
2324390	370867.0	013002	9.12	5.57	3.55
2324579	371139.1	013005	11.47	8.54	2.93
2325378	368702.7	014002	13.23	7.79	5.44
2325851	369243.5	014004	9.72	6.24	3.48
2324931	370399.3	017002	10.47	4.62	5.85
2324907	370122.1	017004	9.80	4.94	4.86
2321674	369851.8	121001	9.15	5.41	3.74
2325481	370865.9	178001	12.23	7.70	4.53
2324188	369586.2	656001	11.23	4.36	6.87
2325329	370272.2	662001	8.62	4.51	4.11
2326044	370000.4	666001	10.59	8.69	1.90
2323892	368830.3	GDH001	13.01	7.12	5.89
2323451	369263.4	GDH002	9.82	4.05	5.77
2323850	370885.1	GDH003	13.20	9.28	3.92
2325925	370792.6	GDH004	11.83	8.69	3.14
2324482	368776.0	GDH005	14.73	8.03	6.70
2323874	371402.2	GDH006	7.59	4.44	3.15
2326380	370412.3	GDH007	12.22	8.84	3.38
2324798	369229.0	GDH008	12.94	6.74	6.20
2324656	368258.4	GDH009	12.78	8.20	4.58
2324284	367779.6	GDH010	9.26	6.30	2.96
2323490	368617.6	GDH011	9.60	6.22	3.38
2325584	366357.8	012001	8.14	4.65	3.49
2325709	366344.0	012002	9.08	4.22	4.86
2325755	366254.8	012003	8.45	4.79	3.66
2324229	371547.5	671003	8.78	5.88	2.90
2324202	371468.5	671004	8.85	5.70	3.15
2324651	367396.1	GDI001	8.73	4.75	3.98
2325176	366908.0	GDI002	11.76	6.84	4.92
2325570	366259.5	GDI003	9.05	5.92	3.13
2326156	365451.3	GDI004	8.65	5.81	2.84
2326383	365995.3	GDI005	9.98	3.59	6.39
2326454	366555.0	GDI006	7.74	3.63	4.11
2326455	367181.4	GDI007	10.31	5.67	4.64
2326482	367772.1	GDI008	11.48	6.31	5.17
2326505	368418.0	GDI009	11.29	4.58	6.71
2326745	368728.6	GDI010	8.05	5.39	2.66
2326636	369618.2	GDI011	8.79	4.73	4.06
2326722	370205.1	GDI012	11.01	11.06	−0.05
2326723	370828.2	GDI013	11.90	8.41	3.49
2326133	371166.9	GDI014	8.75	5.73	3.02
2325533	371205.4	GDI015	11.12	8.52	2.60
2324905	371480.0	GDI016	6.02	4.12	1.90
2324116	371633.4	GDI017	10.25	7.80	2.45
2323773	371635.9	GDI018	7.15	4.33	2.82
2326255	364744.5	GDI019	8.79	6.24	2.55

800 0 800
SCALE FEET

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA

FIGURE 3.6
POTENTIOMETRIC MAP OF
UPPER ZONE/SHALLOW AQUIFER
(5/11/95)

DWG DATE: 12/07/95 | DWG NAME: 29CHZH34

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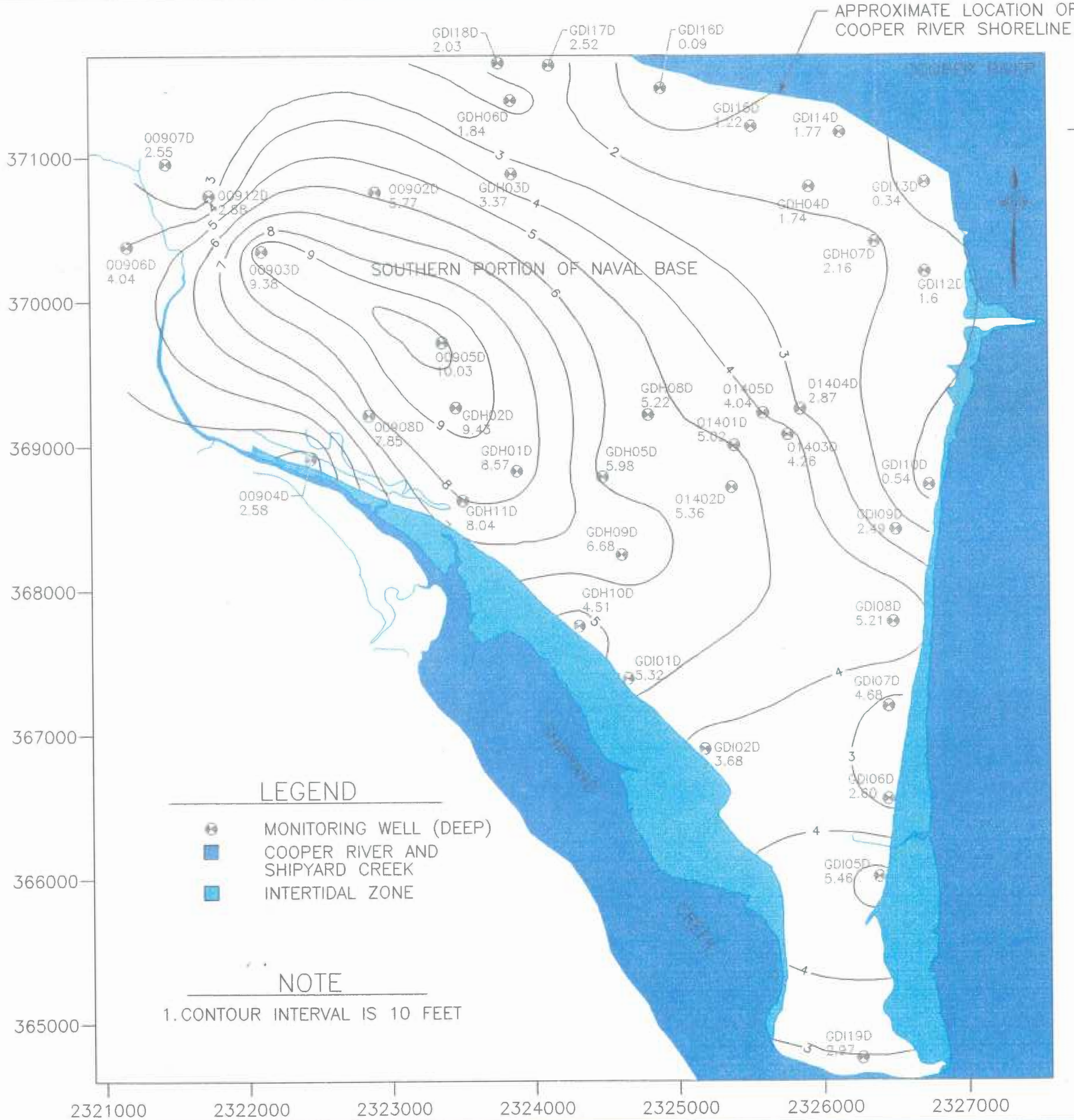

Coordinates X	Coordinates Y	Well	Top of casing Elevations	Depth to Groundwater	Groundwater Elevations
2322898	370759.8	00902D	10.80	5.03	5.77
2322112	370341.4	00903D	9.88	0.5	9.38
2322451	368919.5	00904D	7.19	4.61	2.58
2323331	369705.6	00905D	10.83	0.8	10.03
2321174	370378.8	00906D	13.20	9.16	4.04
2321459	370945.9	00907D	7.73	5.18	2.55
2322861	369251.5	00908D	7.85	0.00	7.85
2321753	370727.7	00912D	9.42	6.54	2.88
2325395	369001.7	01401D	12.58	7.56	5.02
2325376	368713.4	01402D	12.87	7.51	5.36
2325767	369076.1	01403D	11.24	6.98	4.26
2325851	369251.7	01404D	9.38	6.51	2.87
2325602	369226.0	01405D	11.65	7.61	4.04
2323892	368830.3	GDH01D	13.06	4.49	8.57
2323451	369263.4	GDH02D	9.83	0.4	9.43
2323850	370885.1	GDH03D	12.85	9.48	3.37
2325925	370792.6	GDH04D	11.72	9.98	1.74
2324482	368776.0	GDH05D	14.35	8.37	5.98
2323874	371402.2	GDH06D	7.70	5.86	1.84
2326380	370412.3	GDH07D	11.85	9.69	2.16
2324798	369229.0	GDH08D	13.10	7.88	5.22
2324656	368258.4	GDH09D	13.29	6.61	6.68
2324284	367779.6	GDH10D	9.59	5.08	4.51
2323490	368617.6	GDH11D	9.55	1.51	8.04
2324651	367396.1	GDI01D	8.78	3.46	5.32
2325176	366908.0	GDI02D	11.88	8.20	3.68
2326383	365995.3	GDI05D	6.67	1.21	5.46
2326454	366555.0	GDI06D	7.45	4.85	2.60
2326455	367181.4	GDI07D	10.49	7.81	2.68
2326482	367772.1	GDI08D	11.42	6.21	5.21
2326505	368418.0	GDI09D	11.36	8.87	2.49
2326745	368728.6	GDI10D	8.00	7.46	0.54
2326722	370205.1	GDI12D	10.86	9.21	1.65
2326723	370828.2	GDI13D	11.84	11.50	0.34
2326133	371166.9	GDI14D	8.58	6.81	1.77
2325533	371205.4	GDI15D	10.83	9.61	1.22
2324905	371480.0	GDI16D	6.00	5.91	0.09
2324116	371633.4	GDI17D	10.26	7.74	2.52
2323773	371635.9	GDI18D	7.11	5.08	2.03
2326255	364744.5	GDI19D	9.13	6.16	2.97

800 0 800

SCALE FEET

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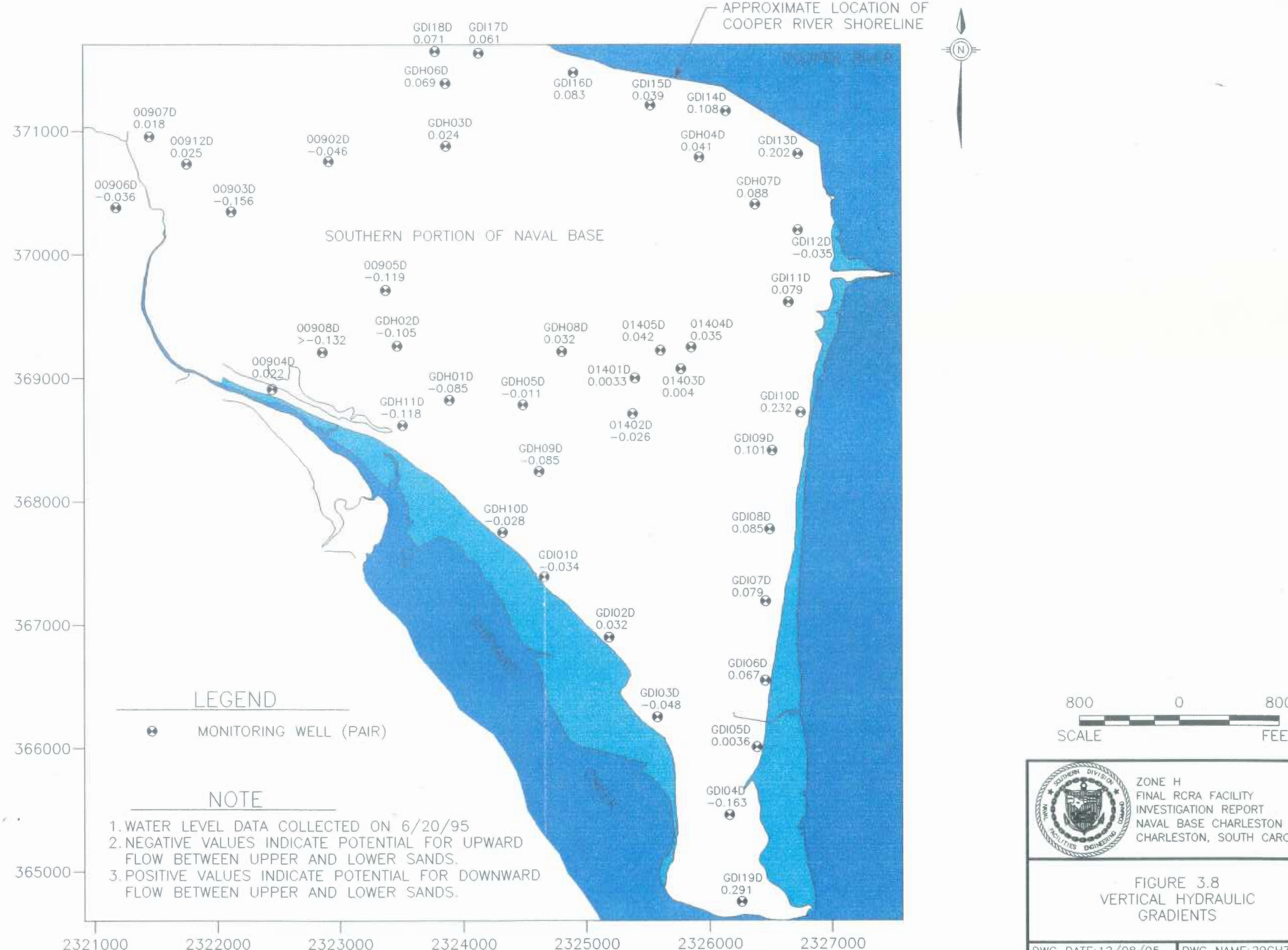
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA

FIGURE 3.7
POTENTIOMETRIC MAP OF LOWER ZONE/SHALLOW AQUIFER (5/11/95)

DWG DATE: 12/07/95 | DWG NAME: 29CHZH36



ZONE H
FINAL RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE CHARLESTON
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FIGURE 3.8
VERTICAL HYDRAULIC GRADIENTS

DWG DATE: 12/08/95 | DWG NAME: 29CHZH42

Table 3.2
Vertical Hydraulic Gradients

Well Pair	Groundwater Elevation Difference (ft)	Vertical Distance (ft)	Vertical Hydraulic Gradient (ft/ft)[a]
NBCH009002/00902D	-1.32	29	-0.046
NBCH009003/00903D	-4.22	27	-0.156
NBCH009004/00904D	0.24	11	0.022
NBCH009005/00905D	-5.01	42	-0.119
NBCH009006/00906D	-0.36	10	-0.036
NBCH009007/00907D	0.81	46	0.018
NBCH009008/00908D	>-3.82	29	>-0.132
NBCH009012/00912D	1.12	44	0.025
NBCH014001/01401D	0.07	21	0.003
NBCH014002/01402D	-0.59	22.5	-0.026
NBCH014003/01403D	0.09	22.5	0.004
NBCH014004/01404D	0.77	22	0.035
NBCH014005/01405D	0.78	18.5	0.042
NBCHGDH001/GDH01D	-3.28	38.5	-0.085
NBCHGDH002/GDH02D	-3.73	35.5	-0.105
NBCHGDH003/GDH03D	0.59	25	0.024
NBCHGDH004/GDH04D	1.59	39	0.041
NBCHGDH005/GDH05D	-0.41	39	-0.011
NBCHGDH006/GDH06D	1.38	20	0.069
NBCHGDH007/GDH07D	1.59	18	0.088
NBCHGDH008/GDH08D	0.79	25	0.032
NBCHGDH009/GDH09D	-2.43	28.5	-0.085
NBCHGDH010/GDH10D	-1.27	45	-0.028
NBCHGDH011/GDH11D	-4.24	36	-0.118

Table 3.2
Vertical Hydraulic Gradients

Well Pair	Groundwater Elevation Difference (ft)	Vertical Distance (ft)	Vertical Hydraulic Gradient (ft/ft)[a]
NBCHGDH019/GDH19D	3.49	12	0.291
NBCHGDI001/GDI01D	-1.15	34	-0.034
NBCHGDI002/GDI02D	1.61	50	0.032
NBCHGDI003/GDI03D	-1.88	39	-0.048
NBCHGDI004/GDI04D	-3.66	22.5	-0.079
NBCHGDI005/GDI05D	0.16	30.5	0.085
NBCHGDI006/GDI06D	1.81	35	0.101
NBCHGDI007/GDI07D	1.78	22.5	0.079
NBCHGDI008/GDI08D	2.58	30.5	0.085
NBCHGDI009/GDI09D	3.55	35	0.101
NBCHGDI101/GDI10D	3.95	17	0.232
NBCHGDI011/GDI11D	1.66	21	0.079
NBCHGDI012/GDI12D	-0.97	27.5	-0.035
NBCHGDI013/GDI13D	3.63	18	0.202
NBCHGDI014/GDI14D	1.62	15	0.108
NBCHGDI015/GDI15D	1.85	47	0.039
NBCHGDI016/GDI16D	2.98	36	0.083
NBCHGDI017/GDI17D	1.61	26.5	0.061
NBCHGDI018/GDI18D	1.56	22	0.071
NBCHGDI019/GDI19D	3.49	12	0.291

Note:
[a](-) = Indicates potential for upward flow.

3.2.7 Horizontal Hydraulic Gradient

The potentiometric maps (Figures 3.6 and 3.7) were examined to find the highest and lowest horizontal hydraulic gradient for each aquifer. Table 3.3 presents horizontal hydraulic gradients for selected well pairs associated with each aquifer. Generally, the well pairs were selected to show the maximum and minimum horizontal gradients measured perpendicular to the water level contours.

Table 3.3
Horizontal Hydraulic Gradient

Shallow Aquifer	Well Pair	Gradient
Upper Sand	NBCIGDI005/NBCIGDI004	0.006
	NBCIGDI004/NBCIGDI019	0.00041
Lower Sand	NBCH00903D/NBCH00912D	0.012
	NBCHGDH09D/NBCIGDI08D	0.00078

3.2.8 Hydraulic Conductivity

Rising and falling head slug tests were conducted to determine the hydraulic conductivity of the surficial aquifers. The hydraulic conductivities for the upper and lower sands are presented in Tables 3.4 and 3.5 respectively. Injecting the slug produced falling head data and rising heads resulted from withdrawal of the slug.

Because hydraulic conductivity data are lognormally distributed, the geometric mean is the best measure of central tendency. Therefore, the average hydraulic conductivity for each well is presented as the geometric mean of the falling and rising head values.

Both rising and falling head slug tests were conducted on tested wells. However, a falling head test was not conducted on NBCH00905D because the water level was too high. If the slug had been introduced instantaneously, well water would have overflowed the casing. Therefore, only a rising head result is presented for this well.

Table 3.4
Zone H
Shallow-Well Slug Test Hydraulic Conductivity Results in feet/day

Well	Falling Head	Rising Head	Geometric Mean*
NBCH009005	0.405	0.373	0.388
NBCH009008	0.260	0.244	0.252
NBCH013002	1.93	2.2104	2.07
NBCH013005	1.94	3.30	2.53
NBCH014001	0.27	0.303	0.286
NBCH014002	1.70	2.30	1.97
NBCH014005	2.20	1.97	2.08
NBCH017001	0.695	1.07	0.863
NBCH178001	0.203	0.103	0.145
NBCH653001	0.712	0.559	0.631
NBCH655001	0.0078	0.0095	0.0086
NBCH656001	0.398	0.475	0.435
NBCH660001	1.82	2.16	1.98
NBCH662001	7.15	6.80	6.97
NBCH663001	20.2	24.9	22.4
NBCH666001	0.507	0.626	0.563
NBCH667001	0.323	0.313	0.318
NBCHGDH004	0.429	0.515	0.470
NBCHGDH005	2.88	4.06	3.42

Note:
* = Average calculated using the falling and rising head values.

Table 3.5
Zone H
Deep-Well Slug Test Hydraulic Conductivity Results in feet/day

Well	Falling Head	Rising Head	Geometric Mean*
NBCH00905D	—	1.48	1.48
NBCH00907D	8.56	11.51	9.9
NBCH01401D	1.71	2.38	2.0
NBCH01402D	1.18	1.11	1.14
NBCH01405D	0.034	0.030	0.032
NBCHGDH05D	1.28	1.28	1.28

Note:
* = Average calculated using the falling and rising head values.

The geometric mean for the slug-tested shallow wells is 1.05 feet/day. This number is generally representative of the upper sand because most of the tested wells are screened across that unit. The geometric mean for the deep wells (all screened across the lower sand) is 0.892 feet/day.

The mean hydraulic conductivities from Tables 3.4 and 3.5 were plotted next to their respective wells on Figure 3.9 to show the areal distribution of hydraulic conductivity.

3.2.9 Horizontal Groundwater Velocity

To estimate the rate at which groundwater and possibly dissolved contaminants are migrating, groundwater velocity was calculated using the following formula:

$$V = \frac{K * i}{n_e}$$

Where:

V = horizontal groundwater velocity
K = hydraulic conductivity
i = horizontal hydraulic gradient
n_e = effective porosity

The average porosity of 37% from the upper sand (Section 3.1.4) was used as the effective porosity in the equation for both aquifers. The maximum and minimum hydraulic gradients and geometric mean hydraulic conductivity for each aquifer were obtained from Sections 3.2.7 and 3.2.8, respectively.

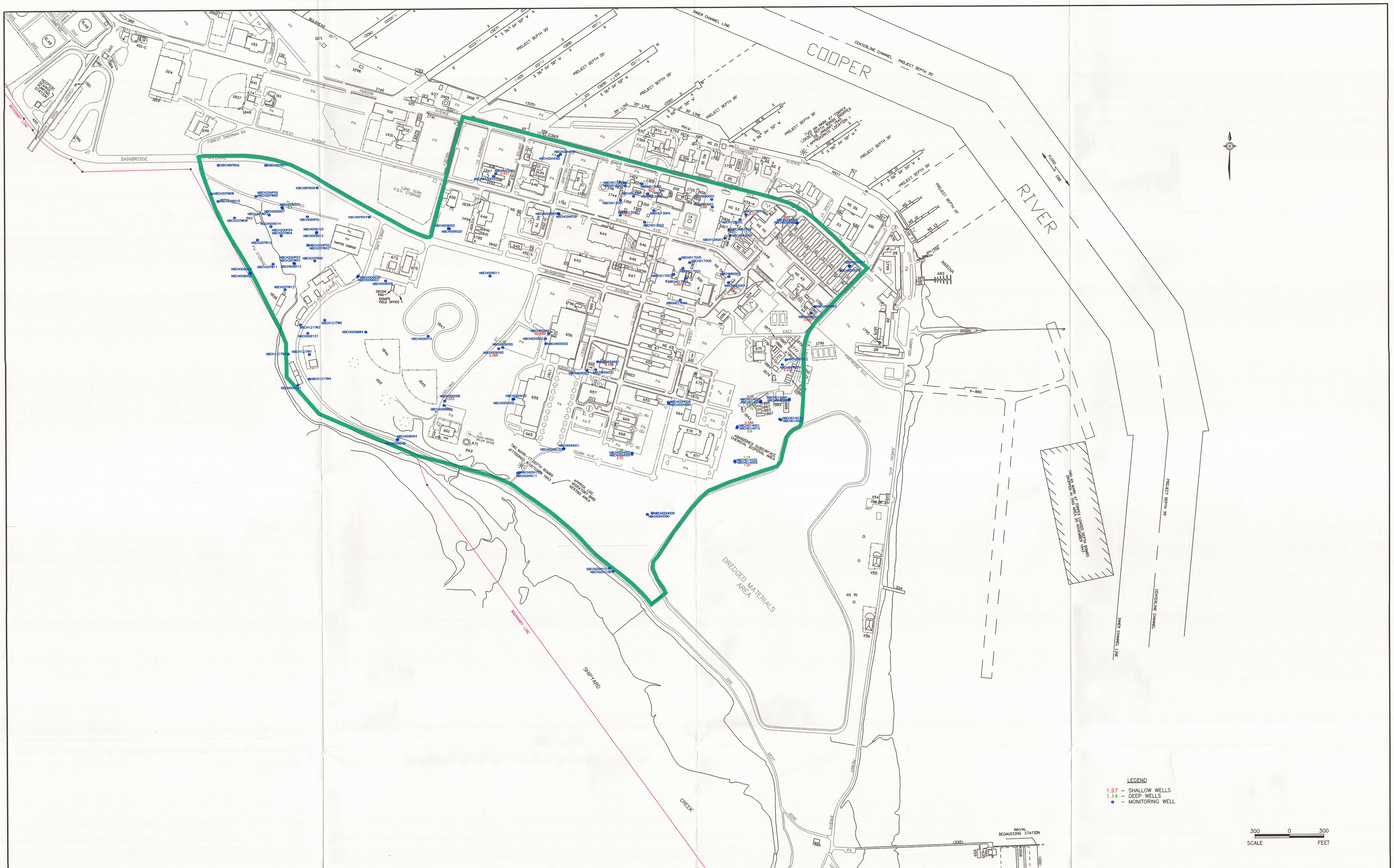
Groundwater velocities for each aquifer are listed below in feet/day:

	Maximum gradient	**Minimum gradient**
Upper Sand	0.017	0.0012
Lower Sand	0.029	0.0019

3.2.10 Zone H Groundwater Usage and Ambient Water Quality

Both the Pleistocene deposits and the Santee Limestone function as potable aquifers in the Charleston region. However, the shallow (Pleistocene) aquifer is poorly developed in the NAVBASE area and is not used on the NAVBASE. A survey of groundwater users within a seven-mile radius of the NAVBASE was provided by the South Carolina Water Resources Commission to ascertain the extent of any shallow groundwater usage. The survey identified no drinking water wells which are screened in the shallow aquifer within a four-mile radius of the NAVBASE. The shallow aquifer overlying the Ashley Formation consists of differentiated sedimentary fluvial deposits extending from the surface to approximately 80 feet bgs. No information relative to intervening aquitards or units capable of significantly impeding downward migration of contaminants was available prior to drilling through the interval of Pleistocene sediments.

Analytical data for various parameters reflective of groundwater quality were obtained from monitoring wells completed in the upper and lower sands of the shallow aquifer (Appendix G). These samples were collected during the first and second zone-wide groundwater sampling events conducted in the fall and winter of 1994 and the spring of 1995. Analytical results from



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 3.9
AREAL DISTRIBUTION OF
HYDRAULIC CONDUCTIVITY IN THE SURFICIAL AQUIFERS

REVISION		
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 001	Rev Date: 07/18/95	Rev By: E. ROGERS

Dr by: E. ROGERS	Tr by: NAME	
Ck by: B. DOTSON	App by: NAME	Sheet 1
Date: 05/25/95	DWG Name: 29CHZH31	Of 1

00376 BBB06X

these samples are summarized in Table 3.6. Standards for groundwater quality listed by the USEPA (1994d) and SCDHEC (1992) are also presented in Table 3.6. Groundwater in Zone H is classified "GB" which SCDHEC considers to be a potable water supply.

Table 3.6
Results of Groundwater Quality Analysis in milligrams per liter (mg/L), except for pH)

Monitoring Well Identification	pH	TDS	Chloride	Sulfate
NBCHGDH001		NS/970	NS/99	NS/150
NBCHGDH01D[a]		NS/22,000	NS/13,000	NS/ND
NBCHGDH002		NS/27,000	NS/16,000	NS/ND
NBCHGDH02D[a]		NS/18,000	NS/10,000	NS/ND
NBCHGDH003	7.09	32,000/2,100	540/740	43/26
NBCHGDH03D[a]	7.23	25,000/26,000	14,000/14,000	620/670
NBCHGDH004		NS/630	NS/69	NS/120
NBCHGDH04D[a]		NS/23,000	NS/13,000	NS/ND
NBCHGDH005		NS/5,800	NS/16,000	NS/ND
NBCHGDH05D[a]		NS/22,000	NS/16,000	NS/ND
NBCHGDH008	6.90	1,400/1,400	69/78	410/430
NBCHGDH008D[a]	6.88	23,000/22,500	12,000/13,000	ND/ND
NBCHGDH007	7.69	260/280	14/21	38/45
NBCHGDH07D[a]		NS/23,000	NS/13,000	NS/10
NBCHGDH006	7.07	1,100/1,100	31/29	350/290
NBCHGDH06D[a]		NS/23,000	NS/12,000	NS/ND
NBCHGDH009	6.84	7,800/8,100	4,700/2,200	1,700/1,900
NBCHGDH09D[a]		NS/24,000	NS/15,000	NS/ND
NBCHGDH010		NS/1,900	NS/380	NS/650
NBCHGDH10D[a]		NS/18,000	NS/9,900	NS/ND

Table 3.6
Results of Groundwater Quality Analysis in milligrams per liter (mg/L), except for pH)

Monitoring Well Identification	pH	TDS	Chloride	Sulfate
NBCHGDH011	6.92	16,000/7,200	21,000/4,000	23/10
NBCHGDH11D[a]		NS/20,000	NS/20,000	NS/ND
SCDHEC Quality Standards for Class GB Groundwater	NL	10000	NL	NL
USEPA Drinking Water Secondary MCLs	6.5 - 8.5	500	250	250

Notes:
NS = Not Sampled.
ND = Not Detected.
NL = Not Listed.
[a] = Deep Wells designed to allow groundwater at the base of the shallow aquifer to be monitored.

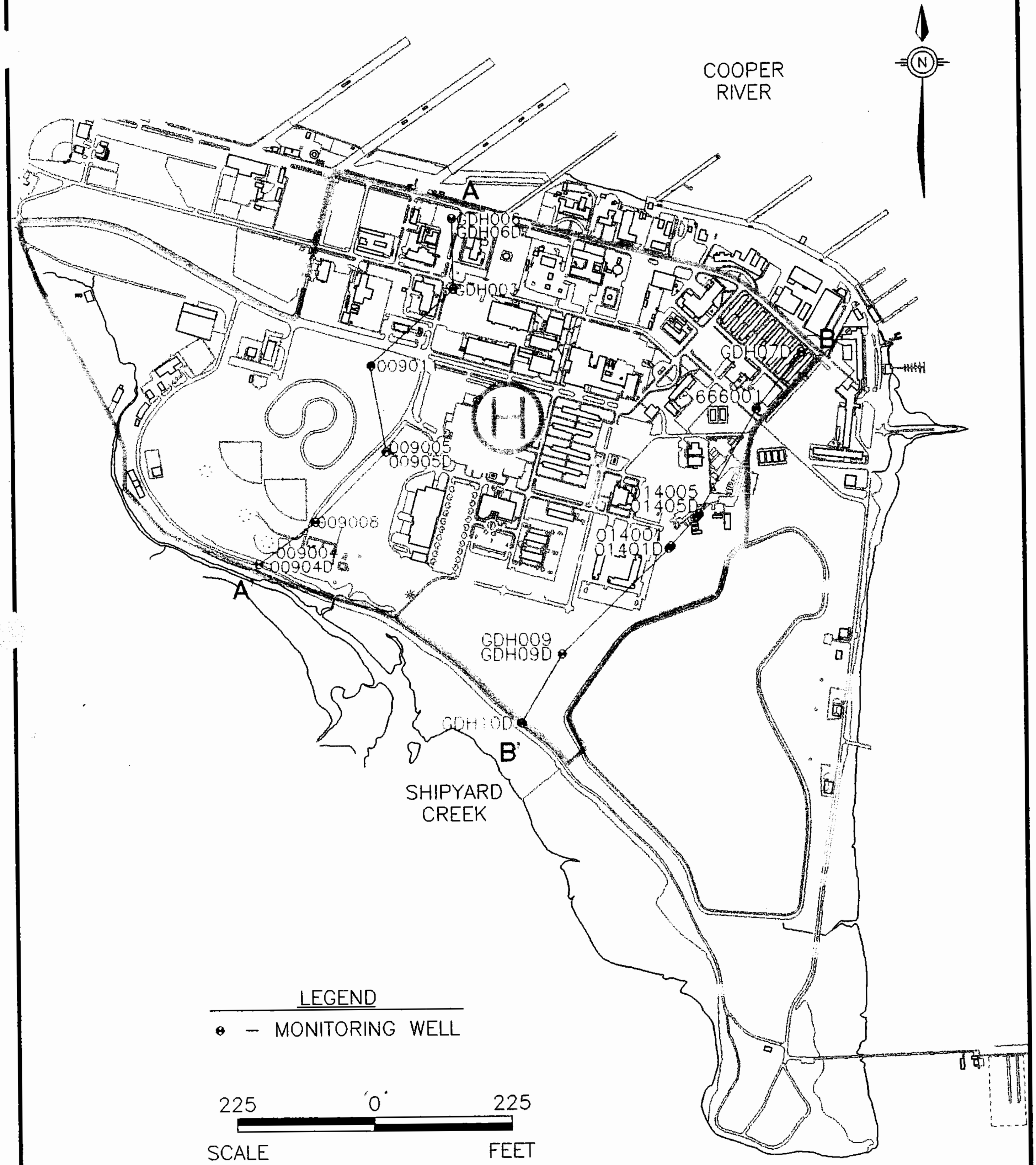
3.3 Tidal Influence Investigation

3.3.1 Objective

Long-term water level monitoring was conducted to determine the effects of tidal fluctuation on wells and groundwater flow throughout Zone H.

3.3.2 Methodology

Wells installed at SWMUs 9 and 14, at AOCs 666 and 667, and at several grid locations were monitored during the investigation. In all, 19 wells (13 shallow and six deep) were monitored; however, data from NBCHGDH010 were unusable due to a data logger malfunction. Wells were selected for monitoring based on their proximity and orientation with respect to tidal areas (Shipyard Creek and Cooper River). Selected wells roughly fall along parallel lines trending northeast/southwest that are perpendicular to Shipyard Creek and sections of the Cooper River. The wells are shown in Cross Sections A-A' and B-B' and listed below. Figure 3.10 illustrates the areal relationship of the monitored wells.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 3.10
WELLS MONITORED DURING THE
ZONE H TIDAL INFLUENCE STUDY

DWG DATE: 12/07/95 | DWG NAME: 29CHZH40

Cross Section A-A'		Cross Section B-B'	
Shallow Wells	**Deep Wells**	**Shallow Wells**	**Deep Wells**
NBCH009004	NBCH00904D	NBCH014001	NBCH01401D
NBCH009005	NBCH00905D	NBCH014005	NBCH01405D
NBCH009008	NBCHGDH06D	NBCH666001	NBCHGDH09D
NBCH009011		NBCH667001	
NBCHGDH003		NBCHGDH007	
NBCHGDH006		NBCHGDH009	

A pressure transducer was placed in each monitored well and connected to an InSitu Well Sentinel or Hermit 1000C data logger programmed to measure and record the water levels on one-hour intervals. A barometric pressure probe was installed at ground level near monitoring well NBCH009008 to a record barometric pressure changes during the tidal monitoring investigation. Data recording started at 6:00 p.m. on December 4, 1994, and continued until the last transducer was removed at 2:30 p.m. on December 8, 1994. The four-day monitoring period spanned nine high and nine low tides.

3.3.3 Results

To determine potential tidal effects on groundwater levels, actual tidal information for the Cooper River at Charleston was obtained from the National Ocean Services of the Department of Commerce (Appendix H). For the four-day monitoring period, the time between high-tide peaks varied between 12 and 12.8 hours, with an average of 12.47 hours. The difference between Cooper River high-tide peaks and low-tide troughs varied between 5.15 and 7.15 feet, with an average of 6.25 feet.

The graph of actual tidal data in Appendix H shows high- and low-tidal peaks and troughs measured in feet and plotted versus time in minutes. The tidal measurements are based on the datum at Charleston which is 5.44 feet above msl. Therefore, 5.44 feet would have to be subtracted from the data points to convert them to feet above msl. For the "x" axis, 0 minutes corresponds to the start of monitoring at 6:00 p.m. on December 4, 1994.

Barometric pressure data for the monitoring period are presented on the second graph in Appendix H. Direct pounds per square inch (psi) measurements from the data logger were converted into feet (of water) by multiplying the psi by 2.307. Then, 34 feet was subtracted from each value so that barometric pressure data could be plotted on the same graph and use the same "y" axis scale as water level data from the wells.

The dotted vertical lines on the graph correspond with the high and low tides that occurred during the monitoring period. The "H" and "L" to the right of each line at the bottom of the graph indicates whether the line represents a high or low tide.

The graph indicates that barometric pressure, like the tides, fluctuates roughly on a 12-hour basis. Moreover, during monitoring, some barometric highs and lows correlated with tidal highs and lows. This correlation makes it difficult to differentiate between barometric and tidal influence on some of the monitored wells. Water level changes in wells that were only slightly impacted by the tides may have been masked by barometric pressure effects. Therefore, lag time and the magnitude of tidal influence could not be discerned from the tidal graphs of some of the wells.

Similar plots of the water level data for each monitored well are presented in Appendix H. A portion of the graphs show water level trend plots for individual wells compared with the plot of barometric pressure. In some of the individual well plots, barometric pressure has been omitted so the water level data could be displayed with more detail.

The sixth graph in Appendix H is a plot used to determine the barometric efficiency (BE) of monitoring well NBCH009005. BE for this well was investigated because water level trends in the well appeared to correlate with changes in barometric pressure more than any other monitored well. This correlation is evident in the fifth graph in Appendix H. On this graph, most decreasing water level trends correspond directly to increases in barometric pressure and conversely, decreases in barometric pressure are associated with increases in water levels.

The BE of NBCH009005 was determined using the method described by Dawson and Istok (1991) in which water level in the well is plotted against the corresponding barometric pressure in feet of water. The correlation between water level and barometric pressure is determined through linear regression of the scatter plot. The slope of the line through the points is BE.

The BE of NBCH009005, which was determined to be nearly 100% using this method, indicates that most of the water level changes in NBCH009005 resulted from barometric pressure changes. No other monitored well displayed as much influence from barometric pressure.

Similar to the tides, water level measurements collected from many of the wells fluctuate from highs to lows on approximately 12-hour intervals. When the groundwater level peaks and troughs are compared to actual high and low tide data for Charleston, the groundwater level highs and lows coincide with the tidal highs and lows. However, the high and low groundwater levels in the wells lag behind the high and low tides by varied amounts of time.

According to Fetter (1988), the lag time of aquifer response to tidal changes is governed by the distance from the tidal source (Cooper River and Shipyard Creek), the extent of hydraulic connection between the aquifer and the source, the tidal period, and the storage coefficient (S) and transmissivity (T) of the aquifer. Generally, lag time increases as distance inland increases.

The lag time for each well was estimated using the graphs in Appendix H. The time of each high tide (vertical dotted line) was subtracted from the time of each discernible water level high to obtain the lag time associated with each tide. For some wells, all nine tide changes were discernible (well NBCH009004 for example) and at others none or only a few were discernable (NBCH009008). The average lag time of all discernible events for each monitored well is presented in Tables 3.7 and 3.8 below.

Table 3.7
Water Level Monitoring Summary of Wells Along Cross Section A-A'

Well	Average Lag Time (hours)	Maximum Change Between High and Low Tide (feet)	Distance from Well to Cooper River/Shipyard Creek (feet)
NBCH009004	1.0	1.12	3150/150
NBCH00904D	1.44	0.65	3150/150
NBCH009005	—	—	2200/1250
NBCH00905D	—	—	2200/1250
NBCH009008	—	—	2670/580
NBCH009011	—	—	1500/1790
NBCHGDH003	1.78	0.11	760/2570
NBCHGDH006	>6	<0.05	200/3100
NBCHGDH06D	2.2	0.16	200/3100

Note:
— = Not Discernible

Table 3.8
Water Level Monitoring Summary of Wells Along Cross Section B-B'

Well	Average Lag Time (hours)	Maximum Change Between High and Low Tide (feet)	Distance from Well to Cooper River/Shipyard Creek (feet)
NBCH014001	—	—	1520/1970
NBCH01401D	—	—	1520/1970
NBCH014005	—	<0.05	1380/2410
NBCH01405D	1.61	—	1380/2410
NBCH666001	1.55	0.07	1150/3270
NBCH667001	2.15	0.54	1300/2750

Table 3.8
Water Level Monitoring Summary of Wells Along
Cross Section B-B'

Well	Average Lag Time (hours)	Maximum Change Between High and Low Tide (feet)	Distance from Well to Cooper River/Shipyard Creek (feet)
NBCHGDH007	1.62	0.34	600/3830
NBCHGDH009	—	<0.05	2000/1110
NBCHGDH09D	—	—	2000/1110

Note:
— = Not Discernible

Wells marked "Not Discernible" indicate that either there were too few water level peaks to estimate tidal influence parameters, or the peaks were not discernible.

The maximum change between succeeding high and low water level events is presented on Tables 3.7 and 3.8 to provide a measure of the magnitude of tidal influence on each well. The amount of groundwater level change was determined by subtracting low-tide groundwater levels from high-tide groundwater levels.

3.3.4 Discussion

Of the wells monitored, lag time varied between a minimum of one hour at NBCH009004 and a maximum of 2.2 hours at NBCHGDH06D. The maximum change between high and low water level was 1.12 feet for the shallow aquifer at NBCH009004 and 0.65 feet for the deep aquifer at NBCH00904D.

Theoretically, lag time should increase and water level change between high and low tide should decrease as distance inland increases. With regard to these typical responses, wells monitored for this tidal study did not behave entirely as expected.

For example, NBCHGDH006 is 560 feet closer to the Cooper River than NBCHGDH003. Yet, NBCHGDH003 had a shorter lag time and a greater change between high and low tide than NBCHGDH006. Moreover, NBCH666001 lies between NBCHGDH007 and NBCH667001 in proximity to both tidal sources. Yet, NBCH666001 has the shortest lag time and the smallest water level change of the three wells.

The variation from the expected tidal pattern exhibited in these wells could be due to varied types of deposits in the aquifer. Well-sorted, coarse-grained deposits would allow for more efficient transmission of tidal influence than fine-grained or poorly sorted deposits. Zone H is underlain primarily by medium- to fine-grained, moderately to well-sorted sand interspersed with lenses of silt, clay, and poorly sorted mixtures of sand, silt, and clay. The lenses are not as transmissive as the more well-sorted sand deposits and therefore would reflect a more subdued response to tidal influence than the sands. Additionally, the former surface topography of the study area has been modified by the disposal of shipyard waste and dredge deposits from the Cooper River. These deposits would exhibit different hydrologic properties than natural deposits. It is likely that the subdued or indiscernible responses seen in many of the monitored wells is due to the presence of fine-grained or poorly sorted deposits.

Wells screened in the shallow and deep aquifer along cross section A-A' indicate that tidal influence from Shipyard Creek may be stronger than that of the Cooper River. Shallow well NBCH009004 is approximately 150 feet from Shipyard Creek and had a maximum change between low and high water levels of 1.12 feet. Well NBCHGDH003 is 760 feet and NBCHGDH006 is 200 feet from the Cooper River; these had only 0.11 feet and less than 0.05 foot of change, respectively. Similarly, deep well NBCH00904D, 150 feet from Shipyard Creek, had 0.65 foot of change while NBCHGDH006D, 200 feet from the Cooper River, had only 0.16 foot of change.

The evidence for greater tidal influence from Shipyard Creek is not as pronounced along cross section B-B' because no monitored wells are within 1000 feet of the creek. However, shallow well NBCH667001 had the most change in water level between high and low tide and it is the well closest to Shipyard Creek of the cross-section B-B' wells that had discernible tidal influence. The deep wells along cross section B-B' could not be compared because only one had discernible influence.

Wells along cross section A-A' indicate that tidal influence in the shallow and deep aquifer decreases as distance inland increases. Wells within 760 feet of a tidal source (NBCH009004, NBCH00904D, NBCHGDH003, NBCHGDH006, and NBCHGDH006D) showed at least some tidal influence. Wells NBCH009005, NBCH00905D, NBCH009008, and NBCH009011 are near the center of the peninsula and they had no discernible tidal influence.

3.3.5 Conclusions

- For the wells influenced by tidal fluctuation, lag time varied between one and 2.2 hours.

- The shallow and deep wells demonstrating the most fluctuation due to tidal influence were NBCH009004 and NBCH00904D, with maximum water level changes of 1.12 and 0.65 feet respectively. These wells are approximately 150 feet from Shipyard Creek and directly adjacent to an area that is inundated daily by the tide.

- The heterogeneity of the aquifer materials may limit or accentuate the tidal response in some wells.

- In general, wells closer to a tidal source were more influenced by tidal change than wells inland on the peninsula. Moreover, tidal influence from Shipyard Creek appears to be greater than that of the Cooper River (possibly because of the quay wall along the river).

- The minimal fluctuations in groundwater levels are not expected to play a significant role in directing contaminants transported by groundwater in any direction other than that determined by the natural groundwater gradient.

3.4 Climate

The climate of the Charleston Harbor area is relatively mild compared to other areas farther inland. The mountains in the northern portion of the state buffer cold air masses from the northwest, and the Bermuda high pressure system limits the progress of cold fronts into the area. These conditions produce relatively mild, temperate winters. Summers are hot and humid, with few temperature extremes. Moderate summer temperatures are largely due to the influence of the Gulf Stream (S.C. SEA Grant Consortium, 1992).

The average monthly air temperatures for the Charleston area are presented in Table 3.9. The temperatures are generally moderated by marine influences and are often 35°F to 37°F lower in the summer and 37°F to 46°F higher in the winter than those areas further inland from the harbor.

The wind direction and velocity in the Charleston area are highly variable, and rather evenly distributed in all directions. The inland portions of the region are subjected to a southwest-northeast wind regime. The prevailing winds are northerly in the fall and winter, and southerly in spring and summer. The monthly average wind velocities and directions for the area range from a low of 7.5 miles per hour (mph) in May to a high of 10.4 mph in March. The average monthly wind speeds and prevailing wind directions are presented in Table 3.9 (S.C. SEA Grant Consortium, 1992).

Table 3.9
Mean Temperature and Wind Data
for Charleston Harbor between 1970 and 1985

Month	Daily Max (°F)	Daily Min (°F)	Mean Speed (mph)	Prevailing Direction
January	61.5	37.6	9.2	SW
February	62.2	40.1	10.3	NNE
March	68	45.1	10.4	SSW
April	76.8	52.7	10	SSW
May	83.8	61.9	8.9	S
June	88.9	69.1	8.5	S
July	88.9	72.0	8.1	SW
August	88.7	70.5	7.5	SW
September	84.6	65.8	8.1	NNE
October	77.2	54.9	8.2	NNE
November	67.8	43.9	8.2	N
December	61.0	38.3	8.7	NNE
Annual	75.7	54.3	8.9	NNE

The Charleston area receives an annual average precipitation of 49 inches, almost all rainfall (Table 3.10). Very little precipitation is recorded as snow, sleet, or hail. The greatest average monthly precipitation normally falls in July while the smallest amount normally occurs in November (Table 3.10) (S.C. SEA Grant Consortium, 1992).

Relative humidity in the Charleston Harbor area is normally very high and fluctuates greatly. Generally, it is higher during the summer months than other times of the year, and the coastal areas exhibit a lower relative humidity than inland portions of the area. The monthly mean relative humidity for four different times of day are presented in Table 3.10 (S.C. SEA Grant Consortium, 1992).

Table 3.10
Monthly and Annual Mean Precipitation, Relative Humidity, and Cloud Cover for Charleston Harbor between 1960 and 1985

		Relative Humidity by Month (%)				Cloud Cover % Number of Days		
Month	Precipitation (inches)	*0100*	*0700*	*1300*	*1900*	*Clear*	*Partly*	*Cloudy*
January	2.54	82	84	55	73	8	8	15
February	3.29	79	82	52	68	9	6	13
March	3.93	81	83	50	67	9	9	13
April	2.88	84	84	50	67	11	8	11
May	3.61	88	84	54	72	8	12	11
June	4.98	90	86	59	75	6	12	12
July	7.71	91	88	64	79	4	13	14
August	6.61	92	91	63	80	5	14	12
September	5.83	91	91	63	82	7	11	12
October	2.84	88	89	56	80	12	8	11
November	2.09	85	87	51	77	13	6	11
December	2.85	82	84	54	74	9	8	14
Annual	49.16	86	86	56	75	101	115	149

Cloud cover varies widely for Charleston, with annual averages of 101 clear days, 115 partly cloudy days, and 149 cloudy days. The average monthly clear, partly cloudy, and cloudy days for the area are presented in Table 3.10 (S.C. SEA Grant Consortium, 1992).

The primary climate concern is tropical cyclones or hurricanes. Hurricanes frequent the east coast of the United States and almost always have some effect on the weather around Charleston Harbor. Hurricanes normally occur between August and December. The last hurricane to make landfall in the Charleston area was Hurricane Hugo, a class IV hurricane which struck Charleston in September 1989 causing severe damage. Tornados are extremely rare in the vicinity but have occurred in the inland portions of Charleston County (S.C. SEA Grant Consortium, 1992).

3.5 Habitat/Biota Survey

Zone H is host to a significant portion of the sensitive ecological habitats at NAVBASE, including several large wetland areas. The basewide habitat evaluation has identified three areas within Zone H as areas of ecological concern (AECs): AEC V-1, the headwaters of Shipyard Creek; AEC V-2, which contains the West Road wetlands and woodland; and, AEC V-3, which contains SWMUs 14, and 15, and AOCs 670 and 684, is a narrow forested area west of the Dredged Material Area (Figure 3.11) (See Section 7 for the detailed Ecological Risk Assessment (ERA) and associated maps). Subzones, which are based on habitat type and potential receptors, will be identified and serve as the investigatory unit during the Zone H ecological risk assessment.

AEC V-1

The headwater region of Shipyard Creek is designated as an AEC for its riparian, wetland, and open field habitats. The Zone H RFI has investigated two SWMUs near AEC V-1, SWMU 19 and SWMU 20. The AEC is bounded on the northeast by Bainbridge Avenue and on the west by an open storage facility used by the Public Works Department.

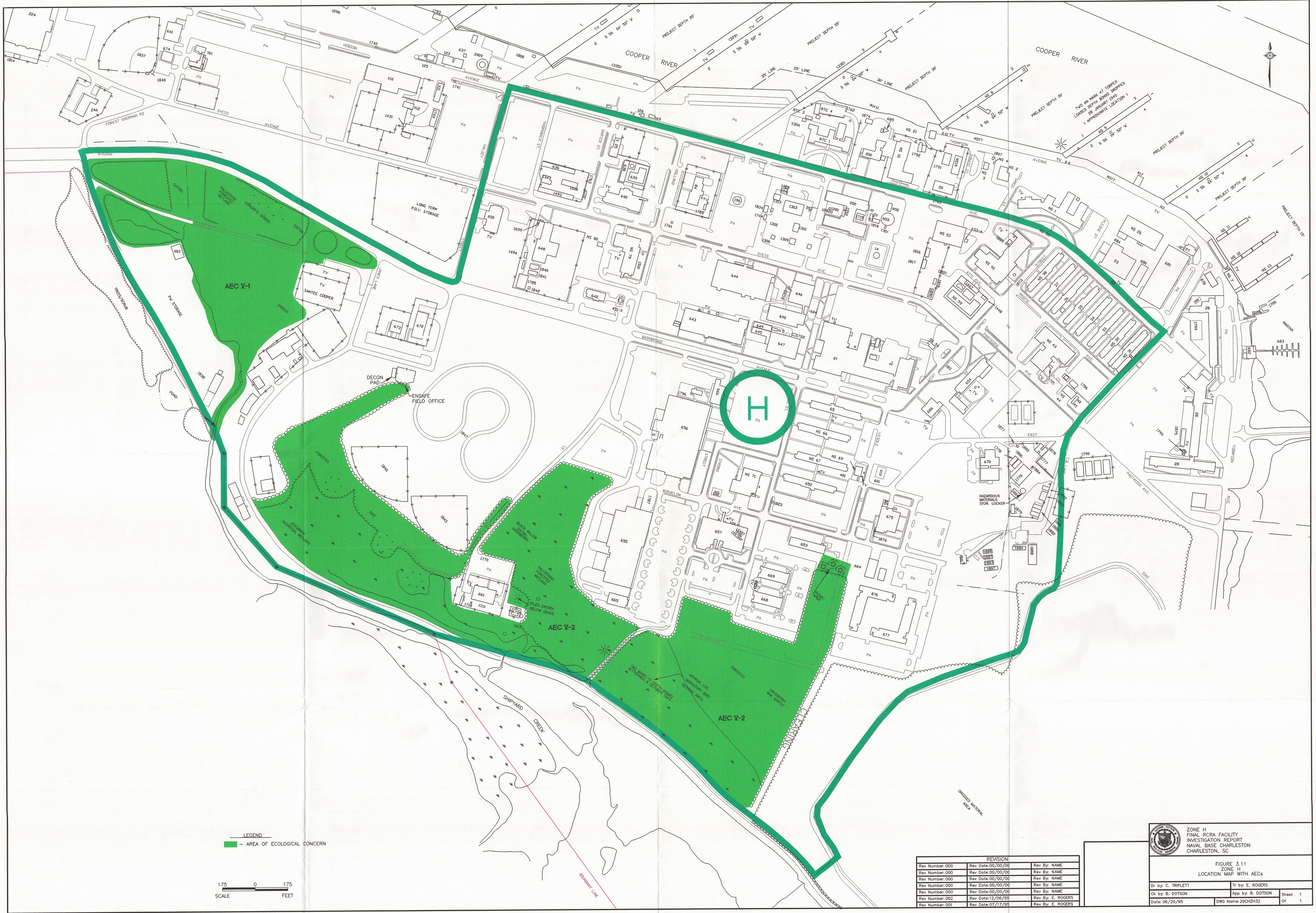
A culvert that drains surface water runoff from the north runs south beneath Bainbridge Avenue and into AEC V-1, creating a forested/scrub-shrub wetland. This wetland extends approximately 1,500 feet southeast along the low-lying area between Bainbridge Avenue and the now overgrown Plate Street. Concrete and asphalt debris was in the roadside portions of the wetland. The headwaters of Shipyard Creek also drain a large offsite wetland south of Viaduct and Bainbridge Roads. The northern portion of AEC V-1 west of Plate Street receives water from an offsite expansive palustrine emergent wetland via a second culvert which runs beneath the to form a larger creek which meanders southward until going offbase near Building 1838. For this headwater portion, the creek banks are high and steep and, at several locations south of Building 1838, frequent surface water runoff is evidenced by deep erosion cuts down the west side of the bank.

Vegetation in the riparian areas of AEC V-1 includes southern hackberry, wax myrtle, black willow, popcorn, red mulberry, and eastern red cedar with a honeysuckle and peppervine understory. The wetland supports populations of cattail, needlerush, and cordgrass. The shallows of these headwaters also have abundant communities of small fish, fiddler crabs, and sand crabs and are, therefore, popular feeding areas for heron, egrets, and kingfishers.

AEC V-2

Another undeveloped portion of Zone H has been designated as AEC V-2. It includes the expansive estuarine intertidal wetland southwest of the athletic fields and the equally large palustrine forested wetland south of Building 655. The palustrine forested wetland is amidst a large wooded tract of land which constitutes the largest contiguous undeveloped upland area at NAVBASE. A posted wading-bird nesting sanctuary is southeast of the athletic fields in AEC V-2. This protected area was established subsequent to the damage caused by Hurricane Hugo in 1989, which demolished most of the mature trees and snags at the former nesting site approximately 1,000 feet to the southeast. The intertidal wetland immediately east of West Road is a salt marsh with irregular topography which allows for areas of nonhydrophytic vegetation. The unimproved West Road separates this wetland from the fringe wetlands of Shipyard Creek, although culverts beneath the road allow tidal influence to extend inland.

Numerous AOC/SWMU sites are in or near AEC V-2, including SWMUs 9, 19, 20, 121, and 159 and AOCs 503, 649, 650, 651, and 654. Additionally, a site which has been the subject of investigations by state and federal environmental agencies is on the opposite shore of Shipyard Creek. This undeveloped portion of Zone H has several different types of habitat,



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Rev Number: 000	Rev Date: 00/00/00	Rev By: NAME
Rev Number: 002	Rev Date: 12/06/95	Rev By: E. ROGERS
Rev Number: 001	Rev Date: 07/17/95	Rev By: E. ROGERS

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 3.11
ZONE H
LOCATION MAP WITH AECs

Dr by: C. TRIPLETT	Tr by: E. ROGERS	
Ck by: B. DOTSON	App by: B. DOTSON	Sheet 1
Date: 06/20/95	DWG Name: 29CHZH32	Of 1

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including an intertidal wetland, a forested wetland, and an upland forest. The intertidal wetland, a former antennae field, receives regular tidal inundation via a culvert and, during exceptionally high tides, flooding over West Road. Distinct channelization is present along the inland side of West Road, aiding receding tidal water drainage. The wetland is bounded on the north and northeast by a slightly elevated band of deciduous forest. The southeastern portion of AEC V-2 supports a second, more expansive upland forest which abuts several parking lots and buildings to the northeast and a clearing which marks the AEC's southern perimeter. The woods between Holland Street and West Road have a slightly lower topography, allowing standing water and hydrophytic vegetation throughout.

The diverse habitats in AEC V-2 host various types of vegetation. Typical estuarine vegetation, such as cattail, cordgrass, and needlerush, is present in the central portions intertidal wetland and wax myrtle, french tamarisk, and black willow are common along the wetland's fringe. The forested portion of the AEC is dominated by several overstory species such as popcorn trees, southern hackberry, and mulberry with loblolly pine, tree-of-heaven, and eastern red cedar tree present in fewer numbers. Common understory species are privet, possumhaw viburnum, saw palmetto, honeysuckle, and virginia creeper.

These habitats play host to a wide variety of wildlife and offer a large area of suitable nesting and foraging habitats. Passerine birds include the cardinal, cedar waxwing, loggerhead shrike, brown thrasher, mockingbird, and mourning dove. Red-tailed hawk, killdeer, egrets, and heron were also observed. Nest boxes had been mounted on the fenceposts along the north end of West Road but were in poor condition and unoccupied. Fiddler crabs are abundant in the mud flat areas in the intertidal wetland and regularly flooded creek banks. Numerous small fish were in the ditch near the culvert leading from Shipyard Creek to the intertidal wetland. Raccoon tracks were also present.

AEC V-2

Zone H also contains a relatively small portion of AEC V-3. Over 90% of this AEC, however, is within Zone I and will be largely assessed during the Zone I (and Zone J) RFI. The portion of AEC V-3 within Zone H contains SWMUs 14, and 15, and AOCs 670, and 684 (all located in the northeast area of AEC V-3) and a narrow forested area west of the Dredged Material Area.

4.0 NATURE OF CONTAMINATION

Sections 4.1 through 4.21 identify all chemicals present in site samples (CPSSs), the frequency of their detections, and range of concentrations of detections for all media sampled at each SWMU or AOC. Sections 4.22 and 4.23 present data collected from the grid-based sampling network and subsequent samples collected based on grid-based soil sample results. Detected concentrations of CPSSs are compared to risk-based screening levels (RBSLs) and/or background concentrations expressed as upper tolerance limits (UTLs) and, where appropriate, ecological screening values in the following Section 4 subsections. The RBSLs listed in each table are taken from U.S. EPA Region III *Risk-Based Concentration Table* (1995).

Because human health risk and hazard and ecological risk will ultimately direct remedial action, detailed discussions of the extent of chemicals of concern (COCs) are deferred to site-specific BRAs presented in Section 6 and 7 of this report. The risk characterization section of each BRA provides risk and hazard maps for COCs (where data support such depictions) to aid in interpreting the risk assessment outputs. Where data points are insufficient to develop a relevant visual presentation, affected locations will be discussed for each medium.

Figure 4.0 shows all soil, sediment, groundwater, and surface water sampling locations for Zone H. Table 4.0.1 lists the number of soil and groundwater samples collected for each round of sampling at each SWMU/AOC and the analyses performed for each set of samples. Table 4.0.2 provides the same information for sediment and surface water samples. Table 4.0.3 compares proposed and actual sample quantities. Each site-specific section closes with an explanation for variations between proposed number of samples and the actual number collected.

Tables presented in Sections 4.1 through 4.21 summarize the complete data packages for AOC and SWMU soil, groundwater, sediment, and surface water analytical data in Appendix I. Each table lists the number of analyses for a particular compound group (i.e., VOCs, SVOCs, metals, pesticides/PCBs), individual compounds or elements within the compound group, number of detections per sampling interval, and the range of detection concentrations at each AOC and SWMU for each interval sampled, along with applicable risk-based screening levels and background concentrations. Dioxin data reflect a summary of the tetrachlorodibenzo-p-dioxin (TCDD) equivalency quotient (TEQ) values as computed using the procedure identified in *Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated dibenzo-p-dioxins and dibenzofurans (CDDs and CDFs)* and 1989 update (USEPA, 1989a). For screening purposes dioxin data are compared to the dioxin TEQ of 1.0 microgram per kilogram (μg/kg) based on a peer-reviewed scientific paper (Kimbrough, et al., 1984). This dioxin concentration was the cleanup level at the Times Beach Superfund Site.

Estimated or "J" values, as identified through the validation process, are included in the data tables as actual values.

For compounds that were detected in the primary sample and also detected in the duplicate sample, the concentrations for both detections are averaged and listed as one detection in the tables. For compounds that were detected in only one of these samples, the value of the one detection is used.

Sample identification numbers may be associated with their respective locations based on the following relationship. An example of a typical soil sample identification number is 013SB00301, which, based on the sample identification discussion provided in Section 2, is a soil sample from the upper interval at boring location 003 at SWMU 13. On the Zone H and SWMU 13 sample location maps, the location from which this sample was collected is labeled 013SB003. An example of a typical groundwater sample identification number is 013GW00301.

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This number indicates a first-round groundwater sample from well 003 at SWMU 13. The corresponding monitoring well identification number is NBCH013003. A typical sediment sample identification number is 009M000101. This sample identification number corresponds to sample location 009M0001 on the SWMU 9 sample location map. Surface water samples follow the same convention as sediment samples.

For SWMU 9 trench soil samples collected in 1993 (example: 009ST01C93), the first three characters represent SWMU 9. The fourth character is for soil sample. Five through eight are for trench number and location on the trench (Location C of Trench 1 for the example). The last two characters distinguish these data as being collected in 1993. For SWMU 9 1993 monitoring well soil samples (example: 009SB02193), the first three characters are for SWMU 9. The fourth character is for soil sample. Five signifies boring. Six and seven denote the monitoring well where the sample was collected, and eight is for the interval (1 or 2) where the sample was collected. The year ('93) is represented by the ninth and tenth characters. For the example given, the soil sample was from SWMU 9 at monitoring well 002 from the upper interval and collected during 1993.

Background Determination

The background concentrations expressed as UTLs were developed following the methods identified in Appendix J.

Data Validation Summary

Introduction

This portion of Section 4 presents the QA/QC evaluation of the data produced from the analyses of samples collected at Zone H of NAVBASE. Data evaluation verifies that the QC requirements of the dataset have been met and characterizes the weakness of questionable data.

Environmental samples were collected at NAVBASE Charleston from August 1994 to May 1995. The samples were analyzed by Pace, Inc. and 100% were reported using USEPA DQO Level III. Project management for Pace, Inc. laboratory was conducted from its New Hampshire location. However, samples were analyzed by several Pace, Inc. laboratories. The following lists laboratories that conducted analyses:

- Pace, Inc., New Hampshire; Level III analyses.
- Pace, Inc., New Orleans; Appendix IX analyses except metals.
- Pace, Inc., Indianapolis; dioxin analysis.
- Pace, Inc., Minnesota; Level III analyses for three sample delivery groups (SDGs).
- Pace, Inc., New Jersey; Level III analyses for two SDGs.

The DQO for Zone H included using USEPA SW-846 and Title 40 Code of Federal Regulations (CFR) Part 264 analytical methods to identify the appropriate analytical levels for site characterization and risk assessment, documenting analytical deliverables using USEPA Level III and Level IV protocols to meet data quality needs, and validating the environmental sample data to ensure that appropriate data quality was obtained. Ten percent of the samples were analyzed for Appendix IX parameters. The Appendix IX parameters are in 40 CFR Part 265 and use SW-846 methods for analysis. The analytical methods and DQO laboratory deliverables are summarized on Table 4.0.4. SCDHEC requires that all laboratories performing analyses for sites in South Carolina be certified by the SC Environmental Laboratory Certification Program. Certification for the listed methods has been verified for Pace's New Hampshire and New Jersey laboratories. At the time the report was produced it had not been confirmed whether the remaining labs were certified. Also, it was uncertain as to whether the program certifies the dioxin method USEPA 8290, which was used during the RFI.

The methods listed in Table 4.0.4 are from:

- USEPA Office of Solid Waste and Emergency Response (OSWER), *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846), Third Edition, revised July 1992.

- USEPA Environmental Monitoring and Support Laboratory, *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020, revised March 1983).

- *Title 40 CFR Part 264, Appendix IX* (52 Federal Register 25947, July 1987).

Third-party independent data validation of all analytical work performed under the CSAP (E/A&H, 1994a) was conducted by Validata Chemical Services based on the QC criteria in the USEPA National Functional *Guidelines for Organic and Inorganic Data Review* (1994a/b). The third-party validator assessed and summarized the data's quality and reliability to determine their usability and to document any factors affecting usability such as compliance with methods, possible matrix interferences, and laboratory blank contamination.

Discrepancies occurred in elevated TPH concentrations at AOCs 653 and 659 and SWMUs 13 and 178. The elevated TPH concentrations detected on a gas chromatograph were not comparable to results of VOA and semivolatile organic analysis (SVOA) which were analyzed by gas chromatography/mass spectrometry (GC/MS). This discrepancy is explained as follows. Petroleum hydrocarbons are made up of paraffinic, cycloparaffinic, and aromatic hydrocarbons. Paraffins (interchangeable with the word alkanes) are a class of aliphatic hydrocarbons which are straight- or branched-chain. TPH can be characterized as diesel range organics (DRO) and gasoline range organics (GRO). DRO consist mainly of fuel and diesel oils, naphtha, lubricating oil, paraffins, and PAH. GRO consist of fractions of hexanes, cycloparffins, and aromatic (cyclohexanes) hydrocarbons.

In comparing VOC analysis with the GRO analysis, the compounds of interest in the VOC scan would be benzene, toluene, ethylbenzene, and xylene. However, gasoline as a whole is only partly made up of these compounds which are considered by-products of gasoline. This is why there is a discrepancy between the GRO and VOC analyses. A somewhat more reliable indication of GRO presence and concentration can be produced through the review of the tentatively identified compounds (TIC) scan in the SW-846 8240 method for volatiles.

If various cyclohexanes, alkanes, and methylbenzenes are present in the TIC scan, then it is a good assumption that GRO has been detected. But quantitation of these compounds is not exact since standards were not analyzed for these compounds. In many cases, the analyst identifies a GRO compound based on the probability of a match. This means that the instrument will tentatively identify a compound, such as a cylcohexane or cycloparaffin, because only a percentage of the mass scan matches. A limitation for identification is the analytical laboratory's mass spectra library in the GC/MS. A typical library contains 50,000 to 70,000 compounds in which standards have been chromatographed. This procedure does not account for petroleum hydrocarbons that do not separate in the GC column and elute as an extremely elevated baseline on the chromatogram. Because of inability to identify compounds, in many cases the term "unknown hydrocarbon or cyclobenzene" will be listed as the TIC.

When a laboratory analyzes a sample for GRO by GC, gasoline is the standard and a rough broad chromatogram is generated producing a fingerprint of the gasoline standard. The chromatogram and standard concentrations are then compared to the environmental samples and a total concentration of GRO is determined.

The laboratory makes a standard for DRO by combining diesel, and diesel No. 6, naphtha, kerosene, and JP-4 fuels. The standard is analyzed on a GC at different concentrations (producing broad chromatograms), samples are compared to standards and results are determined. Like the VOC scan, the 8270 method for SVOC does not list DRO-specific compounds like diesel and kerosene as constituents. To determine if DRO is present in the SVOC analysis, TICs must be reviewed. Again, as with the VOA scan, there is the limitation of the compound library to help with identification. The most likely TICs would be methyl-naphthalenes, alkanes, cycloalkanes, and unknown hydrocarbons.

There is a high probability that when comparing TPH numbers between the VOC and SVOC methods, TPH numbers will not match. In most cases, the results from normal SW-846 8240 and 8270 analyses will be lower, especially if the extracted material is actually petroleum hydrocarbons, rather than compounds for which the method was calibrated.

Organic Evaluation Criteria

The USEPA methods in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (1992d), and *Methods for Chemical Analysis of Water and Wastes* (1983) define QC criteria the laboratory must meet. However, the methods do not address data evaluation from a user's perspective. Data evaluation criteria are available in *USEPA Contract Laboratory National Functional Guidelines for Organic Data Review* (Organic Functional Guidelines), February 1994. For NAVBASE Zone H, these functional guidelines were used throughout the data evaluation process for this purpose.

Data evaluation included the following parameters:

- Holding times
- GC/MS instrument performance checks
- Surrogate spike recoveries
- Instrument calibration
- Matrix spike and matrix spike duplicates (MS/MSDs)
- Blank analysis
- Internal standard (IS) performance

- Compound quantitation
- Field duplicate precision
- Calculations

When the QC parameters do not fall within the specific method guidelines, the data evaluator annotated or "flagged" the corresponding compounds where deficiencies were identified. The following flags were used to annotate data exhibiting laboratory and/or field deficiencies or problems:

U — **Undetected** — The analyte was analyzed for but not detected or was also found in an associated blank, but at a concentration less than 10 times the blank concentration for common constituents (acetone, methylene chloride) or five times the blank concentration for other constituents (benzene, toluene). The associated value shown is the quantitation or reporting limit.

J — **Estimated Value** — One or more QC parameters were outside control limits.

UJ — **Undetected and Estimated** — The analyte was analyzed for but not detected above the estimated quantitation limit. The quantitation limit is estimated because one or more QC parameters were outside control limits.

R/UR — **Unusable Data** — One or more QC parameters grossly exceeded control limits.

EMPC — **Estimated Maximum Possible Concentration** — The dioxin analyte was analyzed for, but due to possible instrument carryover that cannot be verified, results may actually be lower. This qualifier is unique to this document and is further explained in the validation summaries in Appendix K.

NR **Not Reported** — Compounds not on requested list, but were reported on a portion of the samples.

These validation flags were applied to data where deficiencies were noted. Appendix K includes tables of all qualified data.

Holding Times

Acceptable technical holding times are specified in the CSAP. The sample holding time depends on the type of analysis. For water and soil samples, the holding time for VOC analysis is 14 days from the collection date. SVOC, pesticide/PCB, organophosphorus pesticide, and chlorinated herbicide water samples must be extracted within seven days from the collection date and analyzed within 40 days after extraction. For soil, samples must be extracted within 14 days of sample collection and analyzed within 40 days of collection. Dioxin water and soil samples require extraction within 30 days from date of collection and analysis within 45 days of collection.

Holding times for TPH are 28 days from the day of collection for both water and soil samples that are preserved and refrigerated.

GC/MS Instrument Performance Checks

Performance standards for VOC and SVOC analyses are evaluated to determine if the data produced by the instrument may be correctly interpreted according to the requirements of the method being used. Performance standards must be analyzed within 12 hours of sample analysis, and the results must be within the established criteria.

Surrogate Spike Recoveries

Surrogate compounds are added to samples and laboratory blanks before extraction and sample preparation to evaluate the effect of the sample matrix on extraction and measurement procedures. Surrogates are organic compounds chemically similar to analytes of interest, but not normally found in environmental samples. Three surrogate compounds are added to samples for VOC analysis, eight are added to samples for SVOC analysis, two are added to pesticide/PCB and dioxin samples, and one is added to both organophosphorus pesticides and chlorinated herbicides. Percent recovery of the surrogates is calculated by comparing the amount of the compound recovered by the analysis to the amount added to the sample.

The surrogate compounds recommended by the SW-846 methods are listed below. Abbreviations for each compound are in parentheses, when applicable.

VOC Surrogates	SVOC Surrogates	Pesticide/PCB Surrogates	Herbicide Surrogate	Organophosphorus Pesticide Surrogate
Toluene-d8 Bromoflurobenzene (BFB) 1,2-Dichloroethane (DCE)	Nitrobenzene-d5 (NBZ) 2-Fluorobiphenyl (FBP) Terphenyl-d14 (TPH) 2,4,6-Tribromophenol (TBP) Phenol-d5 (PHL) 2-Chlorophenol-d4 (2CP) 1,2-Dichlorobenzene-d4 (DCB) 2-Fluorophenol (2FP)	Tetrachloro-m-xylene (TCMX) Decachlorobiphenyl (DCB)	2,4-Dichloro-phenylacetic acid (DCAA)	4-Chloro-3-Nitrobenzotrifluoride (CNBT)

Dioxin Surrogates
$^{13}C_{12}$ - 1,2,3,4 -Tetrachlorodibenzo-p-dioxin (TCDD) $^{13}C_{12}$ - 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)

Instrument Calibration

Instruments are initially and continually calibrated with standard solutions to verify that they can produce acceptable quantitative data for the compounds.

Initial calibration (GC/MS): The instrument is calibrated at the beginning of the analytical run to check its performance and to establish a linear five-point calibration curve. The initial calibration is verified by calculating the relative response factor (RRF) and the percent relative standard deviation (%RSD) for each compound. An RRF less than 0.05% or a %RSD greater than 30% is outside the QC limits for the initial calibration.

Continuing calibration (GC/MS): Standard solutions are run periodically to check the daily performance of the instrument and to establish the 12-hour RRF on which the sample quantitations are based. The continuing calibration is verified by calculating the RRF and the percent difference (%D) for each compound. An RRF less than 0.05 or a %D greater than 25% is outside the QC limits for the continuing calibration.

Initial calibration (GC): For single-component pesticides, five-point calibrations are analyzed, and calibration factors (CFs) are established. The CF for single-component pesticides must be less than or equal to 20%.

The multicomponent pesticide toxaphene and all PCBs (or Aroclors) are analyzed separately. Retention times and CFs are determined for three to five primary peaks. The only review criteria for multicomponent compounds is to verify these steps were taken.

A five-point initial calibration is analyzed for herbicides, organophosphorus pesticides, and TPH. Two methods for calibration may be used: external or linear regression methods. For the external method, the initial calibration may be verified by calculating the RRF and the %RSD for each compound. An RRF less than 0.05 or a %RSD greater than 20% is outside the QC limits for the initial calibration. If linear regression is used, the correlation coefficient must meet or exceed 0.995 before samples can be analyzed.

Continuing calibration (GC): The calibration verification is to confirm the calibration and evaluate instrument performance for single-component pesticides. The calibration verification consists of a instrument blank, performance evaluation mixture (PEM), and the midpoint concentration of the two standard mixes. The continuing calibration is run on two GC columns (a primary and a secondary) for analyte confirmation. The %D between the calculated amount and the true amount must not exceed 15% on the primary column.

Multicomponent compounds do not require continuing calibration.

For herbicides and organophosphorus pesticides, the continuing calibration is verified by calculating the RRF and the %D for each compound. An RRF less than 0.05% or a %D greater than 15% is outside the QC limits for the continuing calibration.

For NAVBASE, only positive results were flagged when the %RSDs and %D were outside control limits but less than 50%. If the %RSD or %D exceeded 50%, both the positive and nondetected results were flagged. Based on professional judgment, the results were flagged because of the risk in reporting results with a high bias rather than a low bias.

MS/MSD

An MS, used to determine the accuracy of the analysis for a given matrix, consists of a known quantity of stock solution added to the sample before its preparation and analysis. Evaluating the matrix spike data involves two calculations. First, the percent recovery (%R) is calculated by comparing the amount of the compound recovered by the analysis to the amount added to the sample. In addition, the relative percent difference (RPD) between the MS and the MSD samples is calculated and assessed. No specific requirements have been established for qualifying MS/MSD data. However, guidelines to aid in applying professional judgment are discussed in the Organic Functional Guidelines.

Laboratory Control Samples and Laboratory Duplicates

TPH and other GC methods may require laboratory control samples (LCSs) and laboratory duplicates with each SDG. The LCS monitors the overall performance of each step during analysis, including sample preparation. All aqueous LCS percent recovery results must fall within the control limits established by the laboratory. Laboratory duplicate samples are used to demonstrate acceptable method precision at the time of analysis. The RPD between the sample and the duplicate sample is calculated. Although no guidelines are established for organic laboratory duplicates, sample qualification is left to professional judgment.

Blank Analysis

Laboratory method blanks are used to assess the existence and magnitude of potential contamination introduced during analysis. Additionally, field blanks may be collected to assess any contamination introduced while collecting samples. When chemicals are found both in samples and laboratory blanks analyzed within the same 12-hour period and/or field-derived blanks, the usability of the data depends on the reviewer's judgment and the blank's origin. According to the Organic Functional Guidelines, a sample result should not be considered positive unless the concentration of the compound in the sample exceeds 10 times the amount in any blank for common laboratory contaminants (i.e., methylene chloride, acetone, 2-butanone, and phthalate esters), or five times the amount for other constituents. These amounts are referred to as *action levels* (ALs). Because blank samples may not be prepared using the same weight of sample, volume of sample, or dilution, these variables also should be considered when using these blank criteria. The specific actions to be taken are as follows:

- If a chemical is found in the blank but not the sample, no action is taken.

- If the sample concentration is less than the quantitation limit and less than the AL, the quantitation limit is reported.

- If the sample concentration is between the quantitation limit and the AL, the concentration is reported as nondetect "U."

- If the sample concentration is greater than the action level, the concentration may be used unqualified.

Field-Derived Blanks

For this project, four types of field-derived blanks were collected: the field blank, the rinsate blank, the equipment blank, and the trip blank. The field blank is a sample of the source water used onsite, primarily to decontaminate equipment. The rinsate blank is a sample of runoff water from one or more pieces of the decontaminated equipment used to collect samples. The equipment blank is a sample of each filter pack, grout, bentonite pellets, or powder used in well construction. The trip blank is a 40-milliliter (ml) VOA vial filled with certifiable water used to assess cross-contamination during VOC sample shipment.

The frequencies for collecting these QC samples were defined in Section 13 of the NAVBASE CSAP as follows:

- Field blank — one per sampling event (week) per source
- Rinsate blank — one per week per media
- Equipment blank — one sample of each well construction material per source
- Trip blank — one per sample shipping cooler containing VOA samples

For data validation purposes, each trip blank is associated only with the samples from the same shipment or cooler. The field blanks and the rinsate blanks apply to a larger number of samples because only one is collected per sampling event. Because field-derived blanks are used with method blanks to assess potential cross-contamination of field investigative samples, no action was taken if the same contaminants were detected in the method blanks and the associated field-derived blanks but not in the investigative samples.

Internal Standard Performance

GC/MS ISs are added to samples to check the stability of the instrument's sensitivity and response during each analytical VOC and SVOC run. IS area counts for samples and blanks must not vary more than a factor of two (-50% to +100%) from the associated calibration standard. If IS concentration results are outside this window, the sample would be flagged as estimated.

Listed below are the IS compounds recommended by the methods.

VOC	SVOC	Dioxin
Bromochloromethane (BCM)	1,4-Dichlorobenzene-d4 (DCB)	$^{13}C_{12}$- 2,3,7,8-TCDD
1,4-Difluorobenzene (DFB)	Naphthalene-d8 (NPT)	$^{13}C_{12}$- 2,3,7,8-TCDF
Chlorobenzene-d5 (CBZ)	Acenaphthene-d10 (ANT)	$^{13}C_{12}$- 1,2,3,7,8-PeCDD
	Phenanthrene-d10 (PHN)	$^{13}C_{12}$- 1,2,3,7,8-PeCDF
	Chrysene-d12 (CRY)	$^{13}C_{12}$- 1,2,3,6,7,8-HxCDD
	Perylene-d12 (PRY)	$^{13}C_{12}$-1,2,3,4,7,8-HxCDF
		$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD
		$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF
		$^{13}C_{12}$-OCDD

Definitions

TCDD (Tetrachlorodibenzo-p-dioxin)
TCDF (Tetrachlorodibenzofuran)
PeCDD (Pentachlorodibenzo-p-dioxin)
PeCDF (Pentachlorodibenzofuran)
HpCDD (Heptachlorodibenzo-p-dioxin)
HpCDF (Heptachlorodibenzofuran)
HxCDD (Hexachlorodibenzo-p-dioxin)
HxCDF (Hexachlorodibenzofuran)
OCDD (Octachlorodibenzo-p-dioxin)

Diluted Samples

An evaluation of the samples diluted by the laboratory prior to analysis was performed to determine the reasons for the dilutions. The concern being that detection limits may have been elevated above screening concentrations, which could result in COCs being overlooked. In all but four cases, samples were diluted due to the presence of elevated concentrations of site contaminants. Where this occurred, the laboratory was required to report the results of any detections of other compounds at the lower detection limits. Table 4.0.5 lists all diluted samples from Zone H. Four semivolatiles samples had dilution factors ranging from two to five and had a nondetect for results. Of the four, sample 178GW00102 had a high concentration of bis(2-ethylhexyl)phthalate in the laboratory blank, which caused detection limits to be elevated. The remaining three well samples had elevated detection limits due to possible matrix interferences in the samples.

Inorganic Evaluation Criteria

The USEPA methods described in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (1992d), and *Title 40 CFR Part 264, Appendix IX* (1987) define QC criteria the laboratory must meet, but the methods do not address data evaluation from a user's perspective. Evaluation criteria are available in *USEPA Contract Laboratory National Functional Guidelines for Inorganic Data Review* (Inorganic Functional Guidelines), February 1994. The guidelines were used throughout the data evaluation process to address data usability.

Data evaluation for samples collected at NAVBASE included:

- Holding times
- Instrument calibration
- MS results
- Laboratory duplicates
- Blank analysis
- Inductively Coupled Plasma (ICP) interference check samples
- ICP serial dilutions
- Laboratory control sample results

- Atomic Absorption (AA) duplicate injections and post digestion spike recoveries
- Field duplicate precision

According to the Inorganic Functional Guidelines, when the QC parameters do not fall within the specific method guidelines, the data evaluator annotates or "flags" the corresponding compounds where deficiencies were identified. The data from NAVBASE sites were evaluated using this approach. The following flags were used to annotate data exhibiting laboratory and/or field deficiencies or problems:

U **Undetected** — The analyte was analyzed for but not detected above the instrument detection limit (IDL) or was also found in an associated blank at a concentration less than five times the blank concentration.

J **Estimated Value** — One or more QC parameters were outside control limits.

UJ **Undetected and Estimated** — The analyte was analyzed for but not detected above the listed estimated IDL; the IDL is estimated because one or more QC parameters were outside control limits.

R/UR **Unusable Data** — One or more QC parameters grossly exceeded control limits.

NR Not Reported — Compounds not on requested list, but were reported on a portion of the samples.

Holding Times

Acceptable technical holding times are specified in the CSAP (E/A&H, 1994a). For aqueous and soil samples, the holding time for metals analysis is six months, except for mercury, which is 28 days from the date of collection. For aqueous and soil samples, cyanide analysis has a sample holding time of 14 days from the date of collection.

Instrument Calibration

Instruments are initially and continually calibrated with standard solutions to check that they are capable of producing acceptable qualitative and quantitative data for the analytes on the inorganics list.

An initial calibration is conducted to check the instrument's performance at the beginning of the analytical run and to establish a linear calibration curve. Calibration standard solutions are run periodically to check its performance and confirm that the initial calibration curve is still valid. Calibrations are verified by calculating the %R and comparing the amount of the analyte recovered by analysis to the known amount of standard. The %R for metals, except mercury and cyanide, should fall between 90% and 110%. The %R, for mercury and cyanide should fall between 80% and 120% and 85% and 115%, respectively.

Blank Analysis

Laboratory method blanks are used to assess the existence and magnitude of potential contamination introduced during analysis. Additionally, field blanks may be collected to assess the potential contamination introduced during sample collection. When chemicals are found in samples and laboratory blanks, the usability of the data depends on the reviewer's judgment and the blank's origin. According to the Inorganic Functional Guidelines, a sample result should not be considered positive unless the sample concentration exceeds five times the amount in any blank, or the ALs. Because blank samples may not be prepared using the same weight of sample, volume of sample, or dilution, these variables also should be considered when using these blank criteria. The specific actions to be taken are as follows:

- If a chemical is found in the blank but not the sample, no action is taken.

- If the sample concentration is between the IDL, and less than five times the amount found in any blank, the concentration is reported as "U."

- If the sample concentration is greater than five times the amount in any blank, the concentration may be used unqualified.

ICP Interference Check Samples

The ICP interference check sample is used to confirm the laboratory instrument's inter-element and background correction factors. Interference samples should be analyzed at the beginning and end of each sample analysis or at least twice per eight-hour working shift. The %Rs for the interference check sample should fall between 80% and 120%.

Laboratory Control Samples

LCSs are used to monitor the overall performance of steps in the analysis, including the sample preparation. All aqueous LCS %R results must fall within the control limits of 80% to 120%, except for antimony and silver, for which control limits have not been established. Soil LCS standards are provided by the USEPA. Control limits are established for each soil LCS standard prepared.

Spike Sample Analysis

Samples are spiked with known quantities of analytes to evaluate the effect of the sample matrix on digestion and measurement procedures. The %R should be within 75% to 125%. However, when the sample concentration exceeds the spike concentration by a factor of four or more, spike recovery criteria are not applicable.

Laboratory Duplicates

Laboratory duplicate samples are analyzed to evaluate data precision, a measure of the reproducibility of the analysis. The RPD between the sample and its duplicate is calculated. A control limit of 20% RPD should not be exceeded for analyte values greater than 100 times the IDL.

ICP Serial Dilutions

ICP serial dilutions assess the absence or presence of matrix interference. One sample from each set of similar matrix type is diluted by a factor of five. For an analyte concentration that is at least a factor of 100 times above the IDL, the measured concentrations of the undiluted and diluted samples should agree within 10%.

AA Duplicate Injections and Post-Digestion Spike Recoveries

During AA analysis, duplicate injections and postdigestion spikes are used to assess precision and accuracy of the laboratory analysis. The %RSD of duplicate injections must agree within 20%. Percent recovery of the postdigestion spike sample should fall between 85% and 115%.

Table 4.0.1
Summary of Zone H AOC- and SWMU-Specific Soil and Groundwater Sampling

AOC/SWMU	# of First-Round Soil Samples (01 interval/02 interval)	First-Round Analytical Parameters	# of Second-Round Soil Samples (01 interval/02 interval)	Second-Round Analytical Parameters	# of Third-Round Soil Samples (01 interval/02 interval)	Third-Round Analytical Parameters	Groundwater Monitoring Wells Sampled
SWMU 9	11[a]	Metals, VOCs, SVOCs, Pest/PCBs	None Collected	N/A	None Collected	N/A	29
SWMU 13	23/17	Standard Suite, TPH	5/4	Dioxins	None Collected	N/A	9
SWMU 14	9/9	Appendix IX	3/0	Metals	None Collected	N/A	10
SWMU 15	4/4	Standard Suite	4/1	SVOCs	None Collected	N/A	Investigated as SWMU 14
SWMU 17	11/9	Standard Suite, TPH	15/14	Metals, Pest/PCBs, SVOCs	8/8	Dioxins, Pest./PCBs	6
SWMU 19	4/2	Standard Suite	10/0	Metals, SVOCs, Pest/PCBs	4/0	Dioxins, SVOCs, Pest/PCB, Metals	Investigated as SWMU 9
SWMU 20	11/1	VOCs, SVOCs	None Collected	N/A	None Collected	N/A	16[b], Investigated with SWMU 9
SWMU 121	5/0	Standard Suite	6/1	Metals, Pest/PCBs, SVOCs	6/0	Dioxins, Metals, Pest/PCBs, SVOCs	5[c], Investigated with SWMU 9
AOC 663 and SWMU 136	5/2	Standard Suite, TPH	4/1	Metals, Pest/PCB, SVOCs	1/1	SVOCs	3
AOC 667 and SWMU 138	7/7	Standard Suite	None Collected	N/A	None Collected	N/A	2
SWMU 178	6/6	Standard Suite, TPH	None Collected	N/A	None Collected	N/A	2
AOCs 649, 650, 651	9/0	Standard Suite	10/1	Metals, Pest/PCBs, SVOCs	None Collected	N/A	Investigated as SWMU 9

Table 4.0.1
Summary of Zone H AOC- and SWMU-Specific Soil and Groundwater Sampling

AOC/SWMU	# of First-Round Soil Samples (01 interval/02 interval)	First-Round Analytical Parameters	# of Second-Round Soil Samples (01 interval/02 interval)	Second-Round Analytical Parameters	# of Third-Round Soil Samples (01 interval/02 interval)	Third-Round Analytical Parameters	Groundwater Monitoring Wells Sampled
AOC 653	4/2	Standard Suite, TPH	4/4	Dioxins, Pest/PCBs, SVOCs	None Collected	N/A	2
AOC 654	6/5	Standard Suite	None Collected	N/A	None Collected	N/A	None
AOC 655	9/4	Standard Suite, TPH	5/3	Pest/PCBs	None Collected	N/A	3
AOC 656	9/5	Standard Suite, TPH	2/2	SVOCs	None Collected	N/A	3
AOC 659	4/4	Standard Suite, TPH	None Collected	N/A	None Collected	N/A	None
AOC 660	8/2	Standard Suite	None Collected	N/A	None Collected	N/A	2
AOC 662	4/4	Standard Suite, TPH	None Collected	N/A	None Collected	N/A	2
AOC 665	4/4	Standard Suite, TPH	None Collected	N/A	None Collected	N/A	None
AOC 666	7/6	Standard Suite, TPH	None Collected	N/A	None Collected	N/A	2
AOC 670	28/28	Standard Suite, APX9	4/2	SVOCs	3/3	SVOCs	Investigated as SWMU 14
AOC 684	31/22	APX9, TPH	8/3	Pest/PCBs, SVOCs	5/5	SVOCs	Investigated as SWMU 14

Notes:
(a) = Eleven trench samples collected in 1993 investigation.
(b) = Sixteen temporary groundwater sampling locations and Hydropunch sample locations were in the area of SWMU 20. Larger SWMU 9 area encompasses these points.
(c) = Five temporary groundwater sampling locations and Hydropunch sample locations were in the area of SWMU 121. Larger SWMU 9 area encompasses these points.

1) Standard suite of analyses include SW-846 methods for cyanide, metals, SVOCs, VOCs, and pesticides/PCBs.
2) Appendix IX analyses included the standard suite of analyses plus TPH, hexavalent chromium, herbicides, organophosphorus pesticides, dioxins, and more comprehensive lists of VOCs and SVOCs.

Table 4.0.2
Summary of Zone H SWMU- and AOC-Specific Sediment and Surface Water Sampling

SWMU or AOC	Number of Sediment Samples	Analyses	Number of Surface Water Samples	Analyses
SWMU 9	15	Organotin, Cyanide, Metals, Pesticides/PCBs, SVOCs, VOCs, and TOC	4	Cyanide, Metals, Pesticides/PCBs, SVOCs, and VOCs
SWMU 14	4	Cyanide, Dioxin, Herbicides, Hexavalent Chromium, Metals, Organophosphorus Pesticides, Pesticides/PCBs, SVOCs, TPH, and VOCs	1	Cyanide, Dioxin, Herbicides, Hexavalent Chromium, Metal, Organophosphate Pesticides, Pesticides/PCBs, SVOCs, and VOCs
SWMU 159	2	TPH, TOC, Metals, Cyanide, Pesticides/PCBs, SVOCs, and VOCs	1	Cyanide, Metals, Pesticides/PCBs, SVOCs, VOCs, and TPH

Table 4.0.3
Zone H
Quantities of Proposed and Actual Samples

			Soil				Groundwater	
			Upper Interval	Lower Interval	Sediment	Surface Water	Shallow	Deep
SWMU 9 and Associated Sites		Proposed	0	0	15	4	27 (16 Screening Samples)	8
		Actual	0	0	15	4	37 (16 Screening Samples)	8
	SWMU 19	Proposed	4	4				
		Actual	18	2				
	SWMU 20	Proposed	0	0				
		Actual	11	1				
	SWMU 121	Proposed	5	5				
		Actual	17	1				
	AOCs 649, 650, 651	Proposed	9	9				
		Actual	19	1				
	AOC 654	Proposed	6	6				
		Actual	6	5				

Table 4.0.3
Zone H
Quantities of Proposed and Actual Samples

			Soil Upper Interval	Soil Lower Interval	Sediment	Surface Water	Groundwater Shallow	Groundwater Deep
SWMU 13		Proposed	21	21	3 (if accessible)	0	9 (2 existing)	0
		Actual	28	21	0	0	9 (2 existing)	0
SWMU 14 and Associated Sites		Proposed	9	9	1	1	5	5
		Actual	12	9	4	1	5	5
	SWMU 15	Proposed	4	4				
		Actual	8	5				
	AOC 670	Proposed	26	26				
		Actual	35	32				
	AOC 684	Proposed	33	33				
		Actual	44	30				
SWMU 17		Proposed	12	12	0	0	4	0
		Actual	34	31	0	0	6	0
SWMU 178		Proposed	6	6	0	0	2	0
		Actual	6	6	0	0	2	0
AOC 653		Proposed	4	4	0	0	2	0
		Actual	8	6	0	0	2	0
AOC 655		Proposed	9	9	0	0	3	0
		Actual	14	7	0	0	3	0
AOC 656		Proposed	9	9	0	0	3	0
		Actual	11	7	0	0	3	0
AOC 662		Proposed	4	4	0	0	2	0
		Actual	4	4	0	0	2	0
AOC 663 and SWMU 136		Proposed	10	10	0	0	3	0
		Actual	10	4	0	0	3	0

Table 4.0.3
Zone H
Quantities of Proposed and Actual Samples

		Soil				Groundwater	
		Upper Interval	Lower Interval	Sediment	Surface Water	Shallow	Deep
AOC 667 and SWMU 138	Proposed	7	7	0	0	2	0
	Actual	7	7	0	0	2	0
AOC 659	Proposed	4	4	0	0	0	0
	Actual	4	4	0	0	0	0
AOC 660	Proposed	8	8	0	0	2	0
	Actual	8	2	0	0	2	0
AOC 665	Proposed	4	4	0	0	0	0
	Actual	4	4	0	0	0	0
AOC 666	Proposed	6	6	0	0	2	0
	Actual	7	6	0	0	2	0
SWMU 159	Proposed	16	16	2	1	0	0
	Actual	16	3	2	1	0	0
Grid Sample Locations	Proposed	107	107	0	0	12	12
	Actual	96	58	0	0	11	11
Area of GDHSB007 and GDHSB038	Proposed	0	0	0	0	0	0
	Actual	5	5	0	0	0	0
Area of NBCHGDH04D	Proposed	0	0	0	0	0	0
	Actual	4	4	0	0	0	0
Soil-Gas Confirmation Samples	Proposed	0	0	0	0	0	0
	Actual	8	5	0	0	0	0
	Total Proposed	307	307	19	5	73 (16 Screening Samples)	25
	Total Actual	444	270	21	6	89 (16 Screening Samples)	24

Table 4.0.4
NAVBASE Analytical Program

Full Scan/Appendix IX Analytical Methods	Data Quality Level	Method Reference
Volatile Organic Compounds	III/IV	SW-846 8240
Semivolatile Organic Compounds	III/IV	SW-846 8270
Pesticides/Polychlorinated Biphenyls	III/IV	SW-846 8080
Chlorinated Herbicides	III/IV	SW-846 8150
Organophosphorus Pesticides	III/IV	SW-846 8140
Total Petroleum Hydrocarbons	III	USEPA 418.1
Metals	III/IV	40 CFR Part 264 Appendix IX (SW-846 6010/7060/7421/7471/7740/7740)
Hexavalent Chromium	III/IV	USEPA 218.4
Polychlorinated Dibenzo-p-dioxins	III/IV	USEPA 8290

Note:
Full Scan parameters include: VOCs, SVOCs, Pesticides/PCBs, TPH, and Metals (Level III). Appendix IX parameters include: VOCs, SVOCs, Pesticides/PCBs, Herbicides, Organophosphorus Pesticides, Metals, Hexavalent Chromium and Dioxins (Level IV).

Table 4.0.5
Zone H Diluted Sample Results

Sample ID	SDG	Parameter	Dilution Factor	Result (μg/kg)
653SB00401	CHS08	4,4'-DDD	4	180
667SB00302	CHS08	2-Methylnaphthalene	2	2600
667SB00201	CHS08	Bis(2-ethylhexyl)phthalate	2	460 J
667SB00101	CHS08	Bis(2-ethylhexyl)phthalate	2	310 J
653SB00301	CHS08	Bis(2-ethylhexyl)phthalate	8	4300
GDHSB06701	CHS21	4,4'-DDE	10	270 J
GDHSB03801	CHS18	Aroclor-1260	10	4000
655SB00701	CHS10	Dieldrin	5	360
655SB00502	CHS10	Aldrin	5	87
654SB00602	CHS10	Acetone	100	1700 J
GDHSB00701	CHS15	Aroclor-1260	5	2600

Table 4.0.5
Zone H Diluted Sample Results

Sample ID	SDG	Parameter	Dilution Factor	Result (µg/kg)
GDHSB00101	CHS15	Dieldrin	5	300
013SB01902	CHS03	gamma-Chlordane	10	320
013SB01802	CHS03	2-Methylnaphthalene	25	15000
013SB00501	CHS02	4,4'-DDE	10	380
013SB00601	CHS02	4,4'-DDE	10	150
009M000401	CHS12	Fluoranthene	40	9500 J
009M000501	CHS12	Bis(2-ethylhexyl)phthalate	2	830
009M000401	CHS12	Aroclor-1248	5	3000
009M000501	CHS12	4,4'-DDE	5	150
009M001501	CHS12	Aroclor-1260	3	890
009GW01001	CHS25	Chlorobenzene	8.33	1300
665SB00302	CHS07	alpha-Chlordane	20	670
121SB00501	CHS07	Bis(2-ethylhexyl)phthalate	4	1000 J
SGCSB00301	CHS20	4,4'-DDE	3	49
GDHSB06301	CHS20	4,4'-DDD	3	130
SGCSB00101	CHS20	Semivolatiles	4	U
GDHSB06301	CHS20	Naphthalene	2	7500
GDHSB09402	CHS34	4,4'-DDE	150	5700
670SB02901	CHS32	Pyrene	2	6600
690SB00601	CHS28	Benzoic Acid	8	25000
019SB00601	CHS28	Fluoranthene	2	240 J
GDHSW04D07	CHS22	Naphthalene	100	710000
017GW00201	CHS22	Semivolatiles	25	U
017GW00201	CHS22	1,4-Dichlorobenzene	8	1100
GDHSB09602	CHS33	Semivolatiles	5	U
684SB03501	CHS33	Pyrene	8	22000
017SB01901	CHS29	Aroclor-1260	10	1900 J
017SB02002	CHS29	Aroclor-1260	10	2700 J

Table 4.0.5
Zone H Diluted Sample Results

Sample ID	SDG	Parameter	Dilution Factor	Result (µg/kg)
017SB02001	CHS29	Aroclor-1260	1000	180000 J
017SB02301	CHS29	Aroclor-1260	2	1000
655SB01201	CHS29	gamma-Chlordane	5	99
009GW00701	CHS26	Vinyl chloride	5	720
009GW00701	CHS26	4-Methylphenol	40	4400 J
009GW00702	CHS44	4-Methylphenol	50	1400
009GW00702	CHS44	Xylene	2	420
009GW01002	CHS44	Chlorobenzene	2	480
009HW00702	CHS43	Xylene	2.5	520
009HW00702	CHS43	4-Methylphenol	2	240
009HW01002	CHS43	Chlorobenzene	3	560
017GW00202	CHS38	Chlorobenzene	50	4700
017GW00202	CHS38	1,4-Dichlorobenzene	9	910
017HW00202	CHS39	1,4-Dichlorobenzene	4	750
017HW00202	CHS39	Chlorobenzene	50	4800
178HW00102	CHS43	Bis(2-ethylhexyl)phthalate	4	530
GDHGW06D02	CHS38	Bis(2-ethylhexyl)phthalate	2	230
GDHSB05602	CHS19	Semivolatiles	3	U
013G130202	CHS38	Semivolatiles	4	U
655GW00102	CHS41	Semivolatiles	2	U
178GW00102	CHS44	Semivolatiles	5	U

4.1 SWMU 9 (Includes Groundwater, Surface Water, and Sediment for SWMUs 19, 20, and 121, and AOCs 649, 650, 651, and 654)

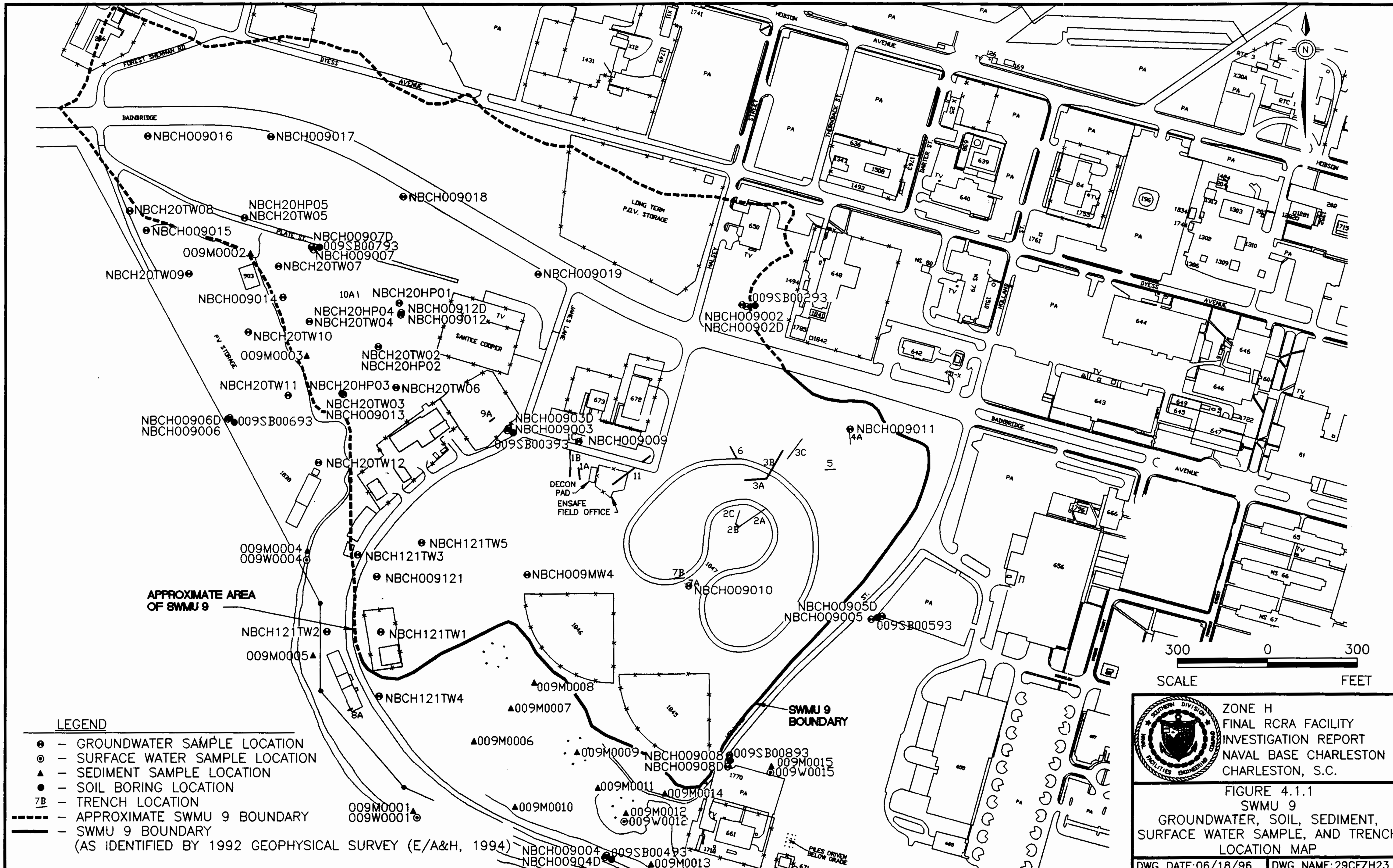
SWMU 9 is a closed landfill at the southern end of NAVBASE that is generally bounded by Shipyard Creek to the southwest, Bainbridge Avenue to the northeast, and Holland Street to the southeast. A geophysical and soil-gas survey was completed in 1992 (E/A&H, 1994c) to enhance the delineation of the geographic boundary of the landfill. Figure 4.1.1 identifies the boundary of SWMU 9 as identified by the geophysical and soil-gas survey. The landfill was used for industrial and domestic solid waste disposal from the 1930s until 1973. Trenching unearthed materials such as medical waste, empty oil containers, empty Freon tanks, cargo netting, gas masks, concrete, wood, and domestic garbage.

Seven additional sites were investigated concurrently with SWMU 9 during the RFI because they were within the landfill perimeter. These sites include SWMU 19, a solid waste transfer station currently in operation; SWMU 20, a waste disposal area which appears to have been used for disposal of industrial-type materials; SWMU 121, a former satellite accumulation area (SAA) associated with a recycling operation; AOC 654, the location of a former septic tank disposal system; and AOCs 649, 650, and 651, areas that formerly stored ship repair supplies.

The intent of the 1992 geophysical and soil-gas survey was to delineate the landfill boundary and identify containers and/or contaminant plumes that may have been in the SWMU 9 area. Following these surveys, exploratory trenches were excavated to identify the source of geophysical anomalies and soil-gas hot spots. The excavations allowed visual observation of the landfill contents at selected locations, but did not conclusively identify significant quantities of buried metallic containers or sources for the soil-gas hot spots. Soil sample analysis from each excavation is discussed below. One of the most significant observations was the conspicuous absence of any cap or impervious layer to prevent surface water infiltration. The landfill generally is covered with 1 to 3 feet of sand and/or sandy silt.

Soil, groundwater, sediment, and surface water sampling was conducted during the RFI. Except for soil sample data, analytical results for SWMU 9 and associated sites are discussed as if they were one site. Soil data from individual sites are discussed separately in this report because contaminant distribution in soil appears to be definable and geographically unique. The data from the analysis of the remaining media sampled, groundwater in particular, indicate that it is more appropriate to discuss the sites collectively since it would be inherently difficult to identify specific point sources for contaminants that may have commingled.

Both temporary and permanent monitoring wells were sampled as part of the groundwater quality investigation of the SWMU 9 area. Temporary wells were installed in SWMUs 20 and 121 to provide data to guide the placement of permanent wells in both areas. Hydropunch technology was initially employed to sample groundwater for screening purposes, but was discontinued due to the type of aquifer material encountered. Standard temporary monitoring wells were constructed after the Hydropunch failed to provide good samples. Sixteen temporary monitoring wells were installed: 11 in SWMU 20 and five in SWMU 121. Each well was installed as described in Section 2. A sample for VOC analysis was collected from each temporary well following construction. Analytical results for the temporary monitoring well samples are presented in Table 4.1.1. These results were used to select permanent monitoring well locations. Five permanent monitoring wells were installed based on the results of the temporary monitoring well sample analysis. Based on VOA results for hydropunch and temporary monitoring well samples the area with the highest quantity of detected VOCs and the highest total concentration of VOCs was near NBCH20HP01. Groundwater samples collected from temporary monitoring well/hydropunch sampling locations NBCH20TW02, NBCH20TW03, NBCH20TW04, NBCH20TW05, NBCH20TW07, NBCH20TW08, and NBCH20TW09 also contained VOCs. Monitoring wells NBCH009012, NBCH00912D, NBCH009013, NBCH009014, and NBCH009015 were installed in the vicinity of these apparently impacted areas or between the areas and Shipyard Creek, the destination for groundwater flow in the SWMU 20 area.



NBCH009016
NBCH009017
NBCH009018
NBCH20TW08
NBCH20HP05
NBCH20TW05
NBCH009015
NBCH00907D
009SB00793
NBCH009007
009M0002
NBCH20TW07
NBCH20TW09
NBCH009019
NBCH009014
NBCH20HP01
NBCH20HP04
NBCH00912D
NBCH20TW04
NBCH009012
NBCH20TW10
009M0003
NBCH20TW02
NBCH20HP02
NBCH20TW11
NBCH20HP03
NBCH20TW06
NBCH20TW03
NBCH009013
NBCH00906D
NBCH009006
009SB00693
NBCH00903D
NBCH009003
009SB00393
NBCH009009
NBCH20TW12
009SB00293
NBCH009002
NBCH00902D
NBCH009011
DECON PAD
ENSAFE FIELD OFFICE
NBCH121TW5
NBCH121TW3
009M0004
009W0004
NBCH009121
NBCH009MW4
NBCH009010
APPROXIMATE AREA OF SWMU 9
NBCH121TW2
NBCH121TW1
NBCH00905D
NBCH009005
009SB00593
009M0005
009M0008
NBCH121TW4
009M0007
SWMU 9 BOUNDARY
009M0006
009M0009
NBCH009008
NBCH00908D
009SB00893
009M0015
009W0015
009M0011
009M0014
009M0012
009W0012
009M0010
009M0001
009W0001
NBCH009004
NBCH00904D
009SB00493
009M0013
PILES DRIVEN BELOW GRADE
LONG TERM P.O.V. STORAGE
SANTEE COOPER
PV STORAGE
FOREST SHERMAN RD
BAINBRIDGE
DYESS AVENUE
HOBSON AVENUE
PLATE ST.
JAMES LANE
HALSEY
THORNBACK ST.
DARTER ST.
HOLLAND
300 0 300
SCALE FEET
LEGEND
— GROUNDWATER SAMPLE LOCATION
— SURFACE WATER SAMPLE LOCATION
— SEDIMENT SAMPLE LOCATION
— SOIL BORING LOCATION
7B — TRENCH LOCATION
— APPROXIMATE SWMU 9 BOUNDARY
— SWMU 9 BOUNDARY
(AS IDENTIFIED BY 1992 GEOPHYSICAL SURVEY (E/A&H, 1994)
ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 4.1.1
SWMU 9
GROUNDWATER, SOIL, SEDIMENT,
SURFACE WATER SAMPLE, AND TRENCH
LOCATION MAP
DWG DATE: 06/18/96
DWG NAME: 29CFZH23

0037BBB012

Five temporary monitoring wells were installed in the vicinity of SWMU 121. VOCs were detected in each of the temporary monitoring well samples. The number of compounds detected and the total concentration of VOCs in each of the five samples were comparable. One permanent monitoring well (NBCH009121) was placed in the approximate center of the SWMU 121 temporary monitoring well pattern.

Based on results of the first round of groundwater sampling of permanent monitoring wells, four additional permanent monitoring well locations were identified. The first round of groundwater samples from these additional wells was collected during the second round of groundwater sampling for all other SWMU 9 wells. Figure 4.1.1 identifies locations for all temporary and permanent monitoring wells in the SWMU 9 area. All temporary wells were abandoned within two days of sampling by pulling the PVC riser casing and screen, and grouting the borehole from the total depth to ground surface with bentonite slurry.

4.1.1 Soil Sampling and Analysis

Eleven trenches were constructed in the SWMU 9 area during the summer of 1993. One soil sample was collected from each trench to characterize the types and concentrations of compounds or elements in SWMU 9. Soil samples were collected in accordance with procedures detailed in Section 2.2 of this report, typically from 2 to 5 feet bgs, depending on the type of waste and the presence of material that could be sampled.

Soil samples were collected during the fall of 1993 at the location of seven monitoring wells. These soil samples were collected in accordance with procedures detailed in Section 2.2 of this report. Upper-interval soil samples were collected at each of seven monitoring well locations. Second-interval soil samples were collected from two of the seven monitoring well locations.

Soil samples (trench and monitoring well) were analyzed for VOCs, SVOCs, metals, and pesticides/PCBs. One trench sample was duplicated for QA purposes. Tables 4.1.2 and 4.1.3

summarize the organic and inorganic data, respectively, for the trench soil samples collected at SWMU 9. Tables 4.1.4 and 4.1.5 summarize the organic and inorganic data, respectively, for the monitoring well soil samples collected at SWMU 9. A complete analytical data report for SWMU 9 soil samples is included in Appendix I. Trench locations are shown on Figure 4.1.1. SWMU 9 soil samples were collected in 1993 as an interim RFI measure. The sampling and analysis plan used during the 1994 RFI had not been developed in 1993, when the soil samples presented in Section 4.1 were collected; therefore, only VOCs, SVOCs, pesticides/PCBs, and metals were analyzed. The results of the soil samples collected in 1993 provided adequate information necessary to characterize the type of waste in the landfill. As a result no additional soil samples were collected to characterize waste in the SWMU 9-specific area during the 1994 RFI. The 1994 RFI of SWMU 9 was designed to determine if contaminants in the landfill were migrating outside its perimeter.

4.1.1.1 Volatile Organic Compounds in Soil

Six VOCs were detected in one or more SWMU 9 trench soil samples. No VOCs were present at concentrations exceeding their respective RBSLs. VOCs ranged from four to seven orders of magnitude below their RBSLs.

Six VOCs were detected in the SWMU 9 1993 monitoring well soil samples. No VOCs were at concentrations exceeding their respective RBSLs. VOC concentrations ranged from three to seven orders of magnitude below their RBSLs.

4.1.1.2 Semivolatile Organic Compounds in Soil

Twenty-four SVOCs were detected in SWMU 9 trench soil samples. Benzo(a)pyrene (RBSL-88 μg/kg) was the only SVOC in the trench samples that exceeded its respective RBSL. This compound was present at trench locations 1C and 10A at concentrations of 440 μg/kg and 430 μg/kg, respectively.

Twenty-one SVOCs were detected in SWMU 9 1993 monitoring well soil samples. Of these compounds only five (all polynuclear aromatic hydrocarbons [PAH]) were detected at concentrations exceeding their respective RBSLs. Benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene were detected at RBSL-exceeding concentrations in the surface soil at monitoring well NBCH009003. Benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and dibenzo(a,h)anthracene were detected at RBSL-exceeding concentrations in the surface soil at monitoring well NBCH009007. No other SVOC detections exceeded their respective RBSLs.

4.1.1.3 Pesticides and PCBs in Soil

Six pesticide compounds were reported in the results for SWMU 9 trench soil samples. None were at concentrations exceeding its RBSL. Concentrations were one to two orders of magnitude below respective RBSLs.

Eight pesticides were detected in the SWMU 9 1993 monitoring well soil samples. None of these compounds were detected at concentrations above their respective RBSL. Concentrations for the pesticide compounds detected in these samples ranged from one to two orders of magnitude below the RBSLs.

PCBs were detected in each trench sample analyzed. Three PCBs (Aroclor-1242, Aroclor-1254, and Aroclor-1260) were at concentrations exceeding the RBSL of 83 μg/kg at trenches 1C, 2A, 3A, 4A, 5A, 6A, 9A, and 10A. The exceedances ranged from one to two orders of magnitude above the RBSL. Most soil samples with the highest concentrations of PCBs were collected at trenches 3A and 5A. The soil sample from trench 3A contained Aroclors-1242 and 1260 at concentrations of 6,700 μg/kg and 1,200 μg/kg, respectively. The soil sample collected from trench 5A contained Aroclor-1254 at a concentration of 2,500 μg/kg.

PCBs were detected in three of the SWMU 9 1993 monitoring well soil samples. Aroclor-1260 was detected in the surface soil at monitoring wells NBCH009005 and NBCH009006 at RBSL-exceeding concentrations. The only other monitoring well soil sample with PCBs was at monitoring well NBCH009008; however, the concentration of Aroclor-1260 in this sample was below the RBSL.

4.1.1.4 Other Organic Compounds in Soil

As explained in Section 4.1.1, analyses for other organic compounds (Appendix IX) were not conducted on soil samples from SWMU 9.

4.1.1.5 Inorganic Elements in Soil

Four elements (beryllium, chromium, lead, and manganese) were detected in trench soil samples at concentrations which exceeded their respective RBSLs and UTLs for background. Antimony was detected in five trench samples at concentrations exceeding its RBSL. No UTL was calculated for antimony.

- Beryllium, trench 8A, 2.1 milligrams per kilograms (mg/kg) (RBSL-0.15; UTL=1.466)
- Chromium, trench 2A, 140.7 mg/kg (RBSL-39; UTL=85.65)
- Lead, trench 3A, 417 mg/kg (RBSL-400; UTL=118)
- Manganese, trench 4A, 791 mg/kg (RBSL-39; UTL=636.4)
- Antimony, all five detections, 9.4 to 26.9 mg/kg (RBSL-3.1)

Only one element (copper) was detected in the SWMU 9 1993 monitoring well soil samples at concentrations which exceeded its RBSL and interval-specific UTL. Copper was detected in the soil at two monitoring wells (NBCH009003 and NBCH009006) at RBSL- and UTL-exceeding concentrations. The following elements: lead, nickel, zinc, aluminum, barium, and beryllium were present in concentrations which were between the lower of the RBSL or UTL and the higher of the RBSL and UTL.

4.1.2 Groundwater Sampling and Analysis (Includes SWMUs 19, 20, and 121; and AOCs 649, 650, 651, and 654)

Seventeen shallow groundwater samples were collected in the primary groundwater sampling event near SWMU 9 to measure shallow groundwater quality. One of the samples was collected from a monitoring well (CST-FMW-4) installed as part of an earlier investigation. Eight deep groundwater samples were collected in the primary groundwater sampling event near SWMU 9 to measure deep groundwater quality. In the first sampling round, both deep and shallow groundwater samples were analyzed for VOCs, SVOCs, pesticides/PCBs, cyanide, and metals. Three shallow groundwater samples were duplicated and submitted for herbicide, hexavalent chromium, dioxin, and organophosphorus pesticide analyses, in addition to the standard suite of analyses. Two of the shallow duplicate samples and one other shallow sample were also analyzed for TPH. Based on the results of the shallow groundwater sample analyses, four additional shallow monitoring wells were constructed along the south side of Bainbridge Avenue (near the northwest boundary of Zone H) and sampled for the standard suite of analytical parameters. One of the four samples was duplicated and submitted for analysis of additional compounds, as above. Although the four additional wells were installed shortly after second-round groundwater sampling had begun, data from analyses of the initial samples collected from the wells have been included with the first-round sample results. Consequently, no second-round samples were collected from these wells.

In the second sampling round at SWMU 9, groundwater samples collected from the 17 original shallow wells and eight deep wells were submitted for analysis of VOCs, SVOCs, pesticides, and metals. Three shallow samples were duplicated and analyzed for the same parameters as the primary samples.

Groundwater sampling was conducted in accordance with procedures detailed in Section 2.4. Tables 4.1.6 and 4.1.7 summarize the organic analytical data for shallow and deep groundwater samples. Tables 4.1.8 and 4.1.9 summarize the inorganic analytical data for SWMU 9 shallow and deep groundwater samples. Appendix I contains a complete report of groundwater analytical data. Groundwater sampling locations are shown on Figure 4.1.1.

4.1.2.1 Volatile Organic Compounds in Groundwater

Thirteen VOCs were detected in shallow groundwater samples collected in the first sampling round from near SWMU 9 (Table 4.1.6). Detected concentrations for seven of the 13 VOCs exceeded respective RBSLs. Benzene and chlorobenzene were the most frequently detected compounds exceeding RBSLs. Benzene (RBSL-0.35 micrograms per liter [μg/L]) was detected in samples from 11 shallow wells at concentrations ranging from 1.8 to 180 μg/L. Chlorobenzene (RBSL-3.9 μg/L) appeared in samples from nine shallow wells at concentration levels of 9 to 1,300 μg/L. The highest concentrations of both benzene (180 μg/L) and chlorobenzene (1,300 μg/L) were reported in the sample from well NBCH009010, near the running track in the middle of the main landfill. In first-round samples from the other wells in SWMU 9, maximum values for benzene and chlorobenzene were 11 μg/L and 63 μg/L, respectively. Both compounds were relatively widespread throughout the western half of the SWMU 9 area, particularly near SWMU 20. Other than those from well NBCH009010, the above-RBSL detections for these compounds were primarily in the northwestern (SWMU 20) area of SWMU 9.

The northern extent of groundwater contamination identified in the SWMU 20 area has not yet been defined. Two of the four additional wells installed along Bainbridge Avenue to determine the northern extent of groundwater contamination near SWMU 20 contained chlorobenzene concentrations above its RBSL. Bainbridge Avenue serves as the northern boundary of Zone H in this area. Upcoming additional fieldwork north of Bainbridge Avenue in Zone G should allow the source of groundwater contamination to be identified.

Other VOCs detected above their RBSLs in shallow first-round samples were carbon disulfide (RBSL-2.1 μg/L), 1,2-dichloroethane (RBSL-0.12 μg/L), 1,2-dichloroethene (total)

(RBSL-5.5 μg/L), ethylbenzene (RBSL-130 μg/L), and vinyl chloride (RBSL-0.019 μg/L). The only reported detections of 1,2-dichloroethane, 1,2-dichloroethene, and vinyl chloride were in the sample from well NBCH009007 (59, 5.5, and 720 μg/L, respectively). This sample also contained the highest detections of toluene (37 μg/L) and total xylene (600 μg/L) as well as the second-highest detection of ethylbenzene (99 μg/L), all at concentrations below their corresponding RBSLs. Eight of the 13 VOCs reported in shallow first-round samples appeared in the sample from this well.

Second-round samples from shallow wells at SWMU 9 contained 14 VOCs, with seven of them at concentrations above their corresponding RBSLs. Benzene and chlorobenzene were the only compounds with multiple detections greater than their RBSLs. The highest reported concentrations of the two compounds were again in the sample from well NBCH009010: benzene at 85 μg/L and chlorobenzene at 520 μg/L. The sample from this well also had the highest reported concentrations of acetone (RBSL-370 μg/L) at SWMU 9: 230 μg/L. Six VOCs appeared only in the sample from well NBCH009007, with five of them exceeding their corresponding RBSLs:

- 1,2-dichloroethane (58 μg/L; RBSL-0.12 μg/L)
- 1,2-dichloroethene (total) (160 μg/L; RBSL-5.5 μg/L)
- methylene chloride (120 μg/L; RBSL-4.1 μg/L)
- trichloroethene (9 μg/L; RBSL-1.6 μg/L), vinyl chloride (415 μg/L; RBSL-0.019 μg/L), and trichlorofluoromethane (52 μg/L; RBSL-130 μg/L)

This sample also contained the highest reported detections of ethylbenzene and toluene, both at concentrations below their RBSLs.

In the first sampling round, three VOCs were detected in two deep groundwater samples collected near SWMU 9 (Table 4.1.7). Two of the three were at concentrations above their respective RBSLs. Carbon disulfide (RBSL-2.1 μg/L) was detected in a groundwater sample from well NBCH00904D at a concentration of 61 μg/L. Chloroform (RBSL-0.15 μg/L) was detected in a groundwater sample from well NBCH00906D at 2.4 μg/L.

No VOCs were detected in second-round groundwater samples from deep monitoring wells at SWMU 9.

4.1.2.2 Semivolatile Organic Compounds in Groundwater

Twenty-six SVOCs were detected in one or more of the shallow first-round groundwater samples from near SWMU 9 (Table 4.1.6). Ten of the SVOCs (azobenzene; benzidine; bis[2-chloroethyl]ether; 1,4-dichlorobenzene; 2,4-dimethylphenol; bis[2-ethylhexyl]phthalate [BEHP]; hexachlorocyclopentadine; 2-methylphenol [o-cresol]; 4-methylphenol [p-cresol]; and pentachlorophenol) appeared at concentrations above their corresponding RBSLs. Compounds with the greatest number of detections exceeding RBSLs in the first round were 1,4-dichlorobenzene (four samples) and pentachlorophenol (three samples). The sample from monitoring well NBCH009007 reported the highest concentrations of four compounds that exceeded RBSLs (bis[2-chloroethyl]ether; 2,4-dimethylphenol; 2-methylphenol; and 4-methylphenol). The sample collected from well NBCH009016 was also highest in four of the above-RBSL compounds (azobenzene, BEHP, hexachlorocyclopentadiene, and pentachlorophenol). The other two compounds that exceeded RBSLs were highest in samples from wells NBCH009010 (1,4-dichlorobenzene) and NBCH009FMW (benzidine). In general, the highest concentrations were detected in the far northwestern part of Zone H, near SWMU 20.

In the second sampling round, 16 SVOCs were detected in samples from shallow wells, with six exceeding their corresponding RBSLs: 1,4-dichlorobenzene, 2,4-dimethylphenol, hexachlorobenzene, hexachlorobutadiene, hexachloroethane, and 4-methylphenol. Of these six, 1,4-dichlorobenzene appeared twice at concentrations above its RBSL, while the other five exceeded their RBSLs only once. Three of the six above-RBSL compounds were highest in the second round in the sample from shallow well NBCH009006 (hexachlorobenzene, hexachlorobutadiene, and hexachloroethane); two were highest in the sample from NBCH009007 (2,4-dimethylphenol and 4-methylphenol); and 1,4-dichlorobenzene was highest in the sample from NBCH009010.

Two SVOCs were detected in deep groundwater samples collected near SWMU 9 during the first sampling round (Table 4.1.7). In neither case did the reported concentration exceed its corresponding RBSL.

No SVOCs were detected in second-round samples from deep monitoring wells near SWMU 9.

4.1.2.3 Pesticides and PCBs in Groundwater

In the first sampling round, dichlorodiphenyl-trichloroethane (DDT) was the only pesticide reported for shallow groundwater samples collected near SWMU 9 (Table 4.1.6). A groundwater sample collected from well NBCH009011 contained 4,4'-DDT at a concentration of 0.06 μg/L, which is well below the RBSL of 0.2 μg/L.

The only pesticides to appear in second-round samples from shallow wells near SWMU 9 were 4,4'-dichlorodiphenyldichloroethane (DDD), 4,4'-dichlorodiphenyldichloroethylene (DDE), and endosulfan I. All three were detected in the sample from well NBCH009015 at concentrations well below their RBSLs.

No pesticide compounds were detected in the deep groundwater samples collected near SWMU 9.

No PCBs were reported for deep or shallow groundwater samples collected near SWMU 9 during the first sampling round. Second-round samples were not submitted for PCB analysis.

4.1.2.4 Other Organic Compounds in Groundwater

Four duplicate shallow groundwater samples from the first round were analyzed for herbicides, dioxins, and organophosphorus pesticides, in addition to the standard suite of analyses. Three samples were submitted for TPH analysis. The herbicide trichlorophenoxyacetic acid (2,4,5-T) was detected in a single sample from well NBCH009016 at a concentration of 0.56 μg/L, nearly two orders of magnitude lower than its RBSL or 37.0 μg/L. Dioxins were detected in three of the four duplicate samples collected near SWMU 9. Dioxin total TEQ concentrations for these three analyses ranged from 0.196 picogram per liter (pg/L) to 2.502 pg/L (Table 4.1.3).

Neither organophosphorus pesticides nor petroleum hydrocarbons were detected in the first-round shallow duplicate samples from near SWMU 9.

Shallow samples from the second round of groundwater sampling at SWMU 9 were not submitted for analysis of herbicides, organophosphorus pesticides, dioxins, or TPH, nor were deep samples from the first or second sampling round.

4.1.2.5 Inorganic Elements in Groundwater

Of the 21 inorganic chemicals detected in at least one first-round shallow groundwater sample from near SWMU 9 (Table 4.1.8), the following nine metals were reported at concentrations exceeding RBSLs: antimony, arsenic, barium, copper, lead, manganese, thallium, vanadium, and chromium (if hexavalent). Antimony, copper, vanadium, and chromium were not detected in enough background samples to determine UTLs. Arsenic, manganese, and thallium concentrations were below their respective UTLs. Lead and barium were detected at concentrations exceeding both their corresponding RBSLs and UTLs. The metals that were reported above their RBSLs most frequently were manganese (in 20 samples), arsenic (in eight samples), barium (in eight samples), and thallium (in five samples). Antimony, chromium, copper, and vanadium detections exceeded their RBSLs in only one sample each (from wells NBCH009016, -012, -MW4, and -006, respectively). The highest concentrations of arsenic (11.5 μg/L) and lead (52.6 μg/L) were in the sample from NBCH009009; barium was highest (1,200 μg/L) in NBCH009018; the highest manganese detection (1,700 μg/L) came from NBCH009012; and thallium was highest in the sample from NBCH009121 (shown on maps as NBCH121001). (*Note:* The chromium RBSL of 18 μg/L is based on hexavalent chromium, which has not been detected in any sample in Zone H. The RBSL for trivalent chromium in tap water is 3,700 μg/L.)

Seventeen inorganic chemicals were detected in second-round samples collected from shallow wells at SWMU 9, with eight of them at concentrations equalling or exceeding their RBSLs: arsenic (above RBSL in nine samples), barium (eight samples), beryllium (one sample), cadmium (one sample), copper (one sample), lead (one sample), manganese (16 samples), and vanadium (one sample). The sample from well NBCH009006 reported the highest concentration of copper (154 μg/L) and vanadium (67.9 μg/L). Highest reported values of the other six above-RBSL metals from deep samples came from six different wells: arsenic at 75 μg/L from NBCH009008, barium at 1,410 μg/L from NBCH009003, beryllium at 1.4 μg/L from NBCH009007, cadmium at 1.8 μg/L from NBCH009014, lead at 33.5 μg/L from NBCH009009, and manganese at 1,990 μg/L from NBCH009002.

No cyanide was detected in any of the 21 shallow first-round groundwater samples. Hexavalent chromium analysis was conducted on four duplicate shallow groundwater samples. Hexavalent chromium was not detected in any of the duplicate samples collected in the first round.

Seventeen inorganic chemicals were detected in at least one deep first-round groundwater sample from near SWMU 9 (Table 4.1.9). Of the 17, five were detected at concentrations exceeding respective RBSLs: arsenic, cadmium, chromium (if hexavalent), manganese, and thallium.

Manganese was the only element detected at concentrations exceeding both its RBSL and UTL. Arsenic concentrations were below its UTL. Cadmium, chromium, and thallium lacked sufficient background detections to determine UTLs. Manganese was detected at concentrations above its RBSL in all eight deep first-round samples, with the highest concentration (805 μg/L) from well NBCH00903D. Arsenic concentrations exceeded RBSL in four samples; the sample from NBCH00907D was highest at 4.8 μg/L. Cadmium, chromium, and thallium were detected in one sample apiece, each of which was above its corresponding RBSL: cadmium at 2.2 μg/L from NBCH00912D, and chromium at 18.1 μg/L and thallium at 160 μg/L from NBCH00904D.

In the second sampling round, eight inorganic chemicals were detected in samples from deep wells near SWMU 9. Only arsenic, cadmium, and manganese were found at concentrations above their RBSLs. Again, manganese exceeded its UTL as well as its RBSL. Arsenic concentrations were above RBSL but below UTL, while cadmium lacked sufficient background detections to establish a valid UTL. Manganese had seven detections above its RBSL, with the two highest from NBCH00903D (1,220 μg/L) and NBCH00907D (1,270 μg/L). All three cadmium detections exceeded its RBSL, with the highest (3.2 μg/L) in the sample from NBCH00906D. The single arsenic detection of 4.1 μg/L was above RBSL, and also came from well NBCH00906D.

Cyanide was detected in the first-round groundwater sample from deep well BNCH00908D at 50 μg/L, slightly below the RBSL of 73 μg/L.

4.1.3 Sediment Sampling and Analysis

Sediment samples were collected from nearby water bodies to measure the potential impact from SWMU 9 and adjacent SWMUs. Fifteen sediment samples and two duplicate sediment samples were collected, each from a depth of 0 to 1 foot below the sediment surface. Tables 4.1.10 and 4.1.11 summarize the organic and inorganic analytical data, respectively, for sediment samples collected at SWMU 9. Appendix I contains a complete report of analytical data for

Zone H. Sediment sampling locations are shown on Figure 4.1.1. The sediment samples were collected from multiple ecological and wetland settings. The ecological risk assessment portion of this document will assess sediment data with regard to the environment in which it was collected.

Contaminant concentrations in the sediment were compared to USEPA Region IV sediment screening values (SSVs) as shown in Table 4.1.10. Sediment screening values and how they relate to ecological risk will be discussed further in the Zone J RFI report.

The 15 sediment samples collected were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, organotin, cyanide, and TOC. The two duplicate samples were analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, herbicides, organophosphate pesticides, cyanide, metals, hexavalent chromium, and dioxins. The positions of all sediment sampling locations were based on areas most likely to have been impacted by a potential release from SWMU 9 or any other nearby SWMU.

4.1.3.1 Volatile Organic Compounds in Sediment

VOCs were detected in eight of the 15 samples analyzed. In the 15 original samples, six different VOCs were detected in the sediment. No detected VOCs have a corresponding SSV. VOCs were detected in both of the duplicates analyzed. Neither carbon disulfide nor toluene has a corresponding SSV.

4.1.3.2 Semivolatile Organic Compounds in Sediment

SVOCs were detected in eight of the 15 samples analyzed. In the 15 original samples, 10 SVOCs were detected. Acenaphthene, fluorene, phenanthrene, and pyrene were detected at concentrations above their SSVs. Benzo(a)anthracene was detected at concentrations below its SSV. Fluoranthene, bis(2-ethylhexyl)phthalate, dibenzofuran, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene were detected but do not have currently listed SSVs.

SVOCs were detected in both duplicate analyses and seven SVOCs were detected. No compounds were detected above their SSVs. Benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, and fluoranthene were detected but do not have currently listed SSVs.

The four SVOCs which were detected above their respective SSVs were in two sediment samples. Pyrene (SSV 380 μg/kg) was detected in a sample collected at location 009M0004 at a concentration of 6,400 μg/kg. Acenaphthene (SSV 16 μg/kg), fluorene (SSV 18 μg/kg), and phenanthrene (SSV 140 μg/kg) were each detected in a sediment sample collected at location 009M0014 at concentrations of 230 μg/kg, 160 μg/kg, and 150 μg/kg, respectively.

4.1.3.3 Pesticides and PCBs in Sediment

Pesticides were detected in 12 of the 15 sediment sample locations. Nine different pesticides were detected in the original 15 samples. Of the nine pesticides detected, only DDT and chlordane have associated SSVs. Alpha- and gamma-chlordane (SSV 0.5 μg/kg for each) were detected at three locations (009M0010, 009M0014, and 009M0015) at concentrations ranging from 2 μg/kg to 29 μg/kg and 1 μg/kg to 26 μg/kg, respectively. 4,4' DDT (SSV 1 μg/kg) was detected at seven sample locations at concentrations ranging from 3 μg/kg to 140 μg/kg. Aldrin, beta-benzene hexachloride (beta-BHC), 4,4'-DDE, 4,4'-DDD, chlorobenzilate, and endrin aldehyde were detected, but had no associated SSVs.

PCBs were detected in eight of the 15 sediment sample locations at concentrations exceeding the SSV of 22.7 μg/kg for total PCBs.

4.1.3.4 Other Organic Compounds in Sediment

One herbicide was detected in one of the two duplicate samples analyzed. The herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) (no SSV) was detected at sample location 009N0010 at a concentration of 47.2 μg/kg.

The organophosphosphorus pesticide parathion (no SSV) was detected in duplicate samples collected at locations 009N0010 and 009N0015 at concentrations of 28.6 μg/kg and 37.2 μg/kg, respectively.

Petroleum hydrocarbons (TPH) (no SSV) were detected in duplicate sample locations 009N0010 and 009N0015 at concentrations of 310,000 μg/kg and 180,000 μg/kg, respectively.

Dioxins (no SSV) were detected in samples collected at both duplicate sample locations (009N0010 and 009N0015) at TEQ concentrations of 5.045 picograms per gram (pg/g) and 15.444 pg/g, respectively.

Organotin compounds were not detected in any of the 15 primary sample locations.

4.1.3.5 Inorganic Elements in Sediment

At least one metal in excess of its SSV was detected in 14 of the 15 sediment sample locations (Table 4.1.11). Metals exceeding their SSVs most frequently were chromium, lead, mercury, copper, arsenic, and zinc.

Hexavalent chromium was not detected in the two duplicate analyses.

Cyanide (no SSV) was detected in one of 15 sediment samples collected. A sediment sample collected at location 009M0007 contained cyanide at a concentration of 2 mg/kg.

4.1.4 Surface Water Sampling and Analysis

Four surface water samples were collected from water bodies near SWMU 9 to measure the potential impact from adjacent SWMUs. One duplicate water sample was analyzed for dioxins only. All surface water samples were collected from 0 to 1 foot below the water surface. Tables 4.1.12 and 4.1.13 summarize the organic and inorganic data, respectively, for SWMU 9 surface water samples. Appendix I contains a complete report of analytical data for Zone H. Surface water sampling locations are shown on Figure 4.1.1.

Contaminant concentrations detected in the surface water were compared to USEPA chronic marine surface water quality criteria. These values, which are shown on Tables 4.1.12 and 4.1.13, are intended only as a screening level comparison to determine the need for further study. Water quality criteria and how they relate to ecological risk will be discussed further in the Zone J RFI report.

Four surface water samples were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. Surface water sampling locations were based on areas most likely to have been impacted by a potential release from SWMU 9 or any other nearby SWMU.

4.1.4.1 Volatile Organic Compounds in Surface Water

VOCs were not detected in any sample locations.

4.1.4.2 Semivolatile Organic Compounds in Surface Water

SVOCs were not detected in any sample locations.

4.1.4.3 Pesticides and PCBs in Surface Water

Pesticides and PCBs were not detected in any sample locations.

4.1.4.4 Other Organic Compounds in Surface Water

Dioxin was detected in the one duplicate surface water sample at 2.246 pg/L. No surface water quality criteria are currently listed for dioxin.

4.1.4.5 Inorganic Elements in Surface Water

At least one metal exceeded USEPA chronic marine surface water quality criteria in three of the four surface water sample locations. Metals which exceeded the water quality criteria most frequently were chromium, lead, nickel, zinc, and copper.

Cyanide was not detected in any surface water sample locations.

4.1.5 Deviations from Final Zone H RFI Work Plan

Forty-eight (24 upper and 24 lower) soil samples were proposed to be collected in the Final Zone H RFI Work Plan (E/A&H, 1994b). The actual number of soil samples collected within the SWMU 9 associated sites is 81 (71 upper interval and 10 lower interval). The upper interval sample was collected at each proposed sample location. Due to shallow depth to groundwater, only some of the second-interval samples were collected from the proposed 24 locations. Based on analytical data for soil samples collected during the sampling phase, additional sample locations were identified. Both sampling intervals were attempted at each of these additional locations. As with the initial phase of sampling, some of the second interval additional samples were not collected due to shallow depth to groundwater.

Sediment and surface water samples were collected from each sample location proposed in the Final Zone H RFI Work Plan.

Sixteen groundwater samples were collected for screening purposes as proposed in the Final Zone H RFI Work Plan. Based on data from the temporary wells, one deep and four permanent monitoring wells were installed. Based on the results of the analysis of groundwater samples collected from the existing monitoring wells and the five wells installed based on temporary monitoring well data, four additional shallow monitoring wells were installed. The total number of permanent monitoring wells sampled in SWMU 9 was 28 (20 shallow and eight deep).

Table 4.0.3 presents the quantities of samples proposed and actual quantities collected from the SWMU 9 associated sites.

Table 4.1.1
Zone H Hydropunch and Temporary Monitoring Well Analytical Results (Results in $\mu g/L$)
Collected from the SWMU 20 and SWMU 121 Areas of SWMU 9

Monitoring Well ID	Ethylbenzene	Toluene	Chlorobenzene	Xylene (Total)	Acetone	Benzene	Methylene Chloride	Carbon Disulfide	Chloroethane	4-Methyl-2-Pentanone	Tetrachloro-ethene	1,2-Dichloroethene (Total)	Vinyl Chloride	Trichloroethene
NBCH20HP01 (16 ft bgs)	—	3.5 J	5.2	2.3 J	131	1.6 J	1.4 J	—	—	—	14.2	168	15.1	19.4
NBCH20HP01 (65 ft bgs)	—	—	—	11.9	5.9 J	—	1.8 J	1.7 J	—	—	—	48.7	9 J	21.2
NBCH20HP02 (52 ft bgs)	—	—	—	—	3.2 J	—	1.3 J	—	—	—	—	—	—	—
NBCH20HP03 (38 ft bgs)	—	—	2.6 J	—	21.6	—	1.9 J	—	—	—	—	—	—	—
NBCH20HP04 (40 ft bgs)	—	—	—	—	17.2	—	2.2 J	1.2 J	—	—	—	—	—	—
NBCH20HP05							No Sample Collected							
NBCH20TW02	2.5 J	3.6 J	6	2.6 J	28	4.9 J	—	—	—	—	—	—	—	—
NBCH20TW03	—	—	20	—	—	3.4 J	—	—	—	—	—	—	—	—
NBCH20TW04	—	—	27	—	—	—	—	—	—	—	—	—	—	—
NBCH20TW05	—	—	59	—	25	—	5	—	—	—	—	—	—	—
NBCH20TW06	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NBCH20TW07	—	—	60	—	—	—	5 J	2.9 J	—	—	—	—	—	—
NBCH20TW08	—	—	—	—	—	140	—	—	—	—	—	—	—	—
NBCH20TW09	—	—	68	—	—	8	—	—	—	—	—	—	—	—
NBCH20TW10	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NBCH20TW11	—	—	—	—	—	—	—	—	12	—	—	—	—	—
NBCH20TW12	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 4.1.1
Zone H Hydropunch and Temporary Monitoring Well Analytical Results (Results in µg/L)
Collected from the SWMU 20 and SWMU 121 Areas of SWMU 9

Monitoring Well ID	Ethylbenzene	Toluene	Chlorobenzene	Xylene (Total)	Acetone	Benzene	Methylene Chloride	Carbon Disulfide	Chloroethane	4-Methyl-2-Pentanone	Tetrachloro-ethene	1,2-Dichloroethene (Total)	Vinyl Chloride	Trichloroethene
NBCH121TW1	—	—	65	—	—	11	—	—	—	—	—	—	—	—
NBCH121TW2	—	—	—	—	64	—	—	—	—	13 J	—	—	—	—
NBCH121TW3	—	1.3 J	—	3.9 J	30	—	—	—	—	—	—	—	—	—
NBCH121TW4	—	—	—	4 J	59	—	4.9 J	—	—	—	—	—	—	—
NBCH121TW5	2.9 J	—	—	33	—	—	—	—	—	—	—	—	—	—

Note:
J = Estimated Value

Table 4.1.2
SWMU 9
Trench Soil Samples
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections	Range of Concentrations for Detections	Risk-Based Screening Levels
Volatile Organic Compounds *(11 Samples Collected)*			
Acetone	11	16-680	780,000
2-Butanone (MEK)	3	2.0-53	4,700,000
1,1,1-Trichloroethane	5	1.0-3.0	700,000
Benzene	3	13-15	22,000
4-Methyl-2-Pentanone (MIBK)	1	1.0	390,000
Toluene	1	13	1,600,000
Semivolatile Organic Compounds *(11 Samples Collected)*			
1,4-Dichlorobenzene	2	38-94	27,000
Naphthalene	1	220	310,000
2-Methylnaphthalene	2	94-120	310,000
Acenaphthylene	1	120	470,000
Acenaphthene	3	99-230	470,000
Dibenzofuran	2	47-100	31,000
Fluorene	3	38-260	310,000
Phenanthrene	8	30-1,100	310,000
3-Methylphenol/4-methylphenol	3	42-100	Not Listed
Anthracene	4	39-85	2,300,000
Di-n-butylphthalate	3	51-120	780,000
Fluoranthene	10	61-990	310,000
Pyrene	10	49-5,600	230,000
Butylbenzylphthalate	4	45-810	1,600,000
Benzo(a)anthracene	4	46-460	880
Chrysene	8	46-2,200	88,000

Table 4.1.2
SWMU 9
Trench Soil Samples
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections	Range of Concentrations for Detections	Risk-Based Screening Levels
Semivolatile Organic Compounds *(11 Samples Collected)*			
bis(2-Ethylhexyl)phthalate (BEHP)	11	90-27,000	46,000
Di-n-ocylphthalate	1	160	160,000
Benzo(a)fluoranthene	8	35-820	880
Benzo(k)fluoranthene	2	90-250	8,800
Benzo(a)pyrene	6	30-440	88
Indeno(1,2,3-cd)pyrene	1	120-210	880
Dibenzo(a,h)anthracene	1	62	88
Benzo(g,h,i)perylene	1	200	310,000
Pesticides *(11 Samples Collected)*			
Aldrin	1	3.9	38
4,4'-DDE	3	6.0-18	1,900
4,4'-DDD	3	5.9-21	2,700
Endrin keton	1	12	2,300
alpha-Chlordane	3	2.5-8.1	470 (alpha + gamma)
gamma-Chlordane	4	5.0-28	
Polychlorinated Biphenyls *(11 Samples Collected)*			
Aroclor-1016	1	44	55
Aroclor-1242	3	360-6,700	83
Aroclor-1254	5	140-2,500	83
Aroclor-1260	4	46-1,300	83

Table 4.1.3
SWMU 9
Trench Soil Samples
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]
Aluminum[a]	11	11	2,160-9,040	7,900	25,310
Antimony	11	5	9.4-26.9	3.1	Not Valid[c]
Arsenic	11	11	1.3-12.4	0.37	14.81
Barium	11	11	8.2-47.9	550	40.33
Beryllium	11	2	0.87-2.1	0.15	1.466
Cadmium	11	6	0.60-2.2	3.9	1.05
Calcium	11	11	240-129,000	Not Listed	Nutrient[d]
Chromium	11	11	6.1-140.7	39	85.65
Cobalt	11	10	1.8-12.8	470	5.863
Iron[a]	11	11	2,150-21,000	Not Listed	30,910
Lead	11	10	2.6-417	400	118
Magnesium[a]	11	10	119-5,530	Not Listed	9,592
Manganese[a]	11	11	4.3-791	39	636.4
Mercury	11	10	0.01-0.47	2.3	0.485
Nickel	11	11	5.7-131	160	33.38
Potassium[a]	11	11	141-1,070	Not Listed	Nutrient[d]
Sodium[a]	11	7	74.5-1,090	Not Listed	Nutrient[d]
Vanadium	11	10	7.0-59.9	55	77.38
Zinc	11	8	16.9-1,430	2,300	214.3

Notes:
(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = See Appendix J for UTL determination.
(c) = Number of nondetections prevented determination of UTL.
(d) = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.1.4
SWMU 9
1993 Monitoring Well Soil Samples
Organic Compounds in Soil (mg/kg)

Chemical	009SB02193 at NBCH009002	009SB02293 at NBCH009002	009SB03193 at NBCH009003	009SB04193 at NBCH009004	009SB05193 at NBCH009005	009SB05293 at NBCH009005	009SB06193 at NBCH009006	009SB07193 at NBCH009007	009SB008193 at NBCH009008	RBSL
Volatile Organic Compounds										
Acetone	ND	ND	160 J	ND	ND	ND	ND	ND	ND	780,000
Methylene Chloride	ND	ND	ND	ND	ND	23	ND	ND	ND	85,000
Tetrachloroethene	ND	ND	ND	ND	31	ND	ND	ND	ND	12,000
Chlorobenzene	31	ND	15 J	13 J	12	ND	ND	ND	18 J	160,000
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	5.7	ND	780,000
Xylene (Total)	ND	ND	5.7 J	ND	ND	ND	ND	11	ND	16,000,000
Semivolatile Organic Compounds										
Naphthalene	ND	ND	76 J	ND	ND	ND	ND	820 J	ND	310,000
2-Methylnaphthalene	ND	ND	67 J	ND	ND	ND	ND	790 J	ND	310,000
2,4-Dinitrophenol	ND	ND	210 J	ND	ND	ND	ND	ND	ND	16,000
Dibenzofuran	ND	ND	130 J	ND	ND	ND	ND	1,800 J	ND	31,000
Fluorene	ND	ND	220 J	ND	ND	ND	ND	3,200	ND	310,000
Phenanthrene	ND	ND	1,700 J	59 J	32 J	ND	91 J	16,000	31 J	310,000
Anthracene	ND	ND	430 J	ND	ND	ND	ND	3,400	ND	2,300,000
Carbazole	ND	ND	230 J	ND	ND	ND	ND	2,800	ND	Not Listed

Table 4.1.4
SWMU 9
1993 Monitoring Well Soil Samples
Organic Compounds in Soil (mg/kg)

Chemical	009SB02193 at NBCH009002	009SB02293 at NBCH009002	009SB03193 at NBCH009003	009SB04193 at NBCH009004	009SB05193 at NBCH009005	009SB05293 at NBCH009005	009SB06193 at NBCH009006	009SB07193 at NBCH009007	009SB008193 at NBCH009008	RBSL
Semivolatile Organic Compounds										
Fluoranthene	ND	ND	2,700 J	69 J	ND	ND	270 J	16,000	53 J	310,000
Pyrene	73 J	72 J	3,800 J	110 J	110 J	ND	290 J	16,000	54 J	230,000
Benzo(a)anthracene	ND	ND	1,500 J	ND	ND	ND	ND	5,500	ND	880
Chrysene	ND	ND	1,500 J	ND	39 J	ND	110 J	6,100	36 J	88,000
bis(2-ethylhexyl)-phthalate	ND	ND	2,500 J	ND	ND	ND	120 J	3,700	ND	46,000
Benzo(b)fluoranthene	56 J	ND	2,100 J	66 J	ND	ND	100 J	8,300	59 J	880
Benzo(k)fluoranthene	ND	ND	690 J	ND	ND	ND	ND	2,600	ND	8,800
Benzo(a)pyrene	ND	ND	1,400 J	ND	38 J	ND	58 J	5,100	34 J	88
Indeno(1,2,3-cd)-perylene	ND	ND	890 J	ND	ND	ND	ND	ND	ND	880
Benzo(g,h,i)perylene	ND	ND	760 J	ND	ND	ND	ND	ND	18 J	310,000
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	2,700	ND	470,000
Butylbenzyl phthalate	ND	ND	ND	ND	71 J	ND	ND	ND	ND	1,600,000

Table 4.1.4
SWMU 9
1993 Monitoring Well Soil Samples
Organic Compounds in Soil (mg/kg)

Chemical	009SB02193 at NBCH009002	009SB02293 at NBCH009002	009SB03193 at NBCH009003	009SB04193 at NBCH009004	009SB05193 at NBCH009005	009SB05293 at NBCH009005	009SB06193 at NBCH009006	009SB07193 at NBCH009007	009SB008193 at NBCH009008	RBSL
Semivolatile Organic Compounds										
Di- benzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	470 J	ND	88
Pesticides										
4,4'-DDE	ND	27 J	ND	ND	ND	ND	50 J	10 J	ND	1,900
4,4'-DDD	ND	92	ND	ND	ND	ND	ND	12 J	ND	2,700
4,4'-DDT	ND	14 J	ND	ND	ND	ND	ND	ND	ND	1,900
Heptachlor Epoxide	ND	ND	ND	ND	2.5 J	ND	ND	ND	ND	70
Dieldrin	ND	ND	ND	ND	ND	ND	4.8 J	ND	ND	40
alpha-Chlordane	ND	ND	ND	ND	1.9 J	ND	ND	ND	14 J	470 (alpha/gamma)
gamma-Chlordane	ND	ND	ND	ND	11 J	ND	ND	8.3 J	18 J	
Endrin aldehyde	ND	ND	ND	ND	ND	ND	ND	15 J	ND	2,300
PCBs										
Aroclor-1260	ND	ND	ND	ND	360	ND	230 J	ND	97 J	83

Notes:
ND = Compound not detected above method detection limit.
J = Estimated Value

Table 4.1.5
SWMU 9
1993 Monitoring Well Soil Samples
Inorganic Compounds in Soil (mg/kg)

Element	009SB02193 at NBCH009002	009SB02293 at NBCH009002	009SB03193 at NBCH009003	009SB04193 at NBCH009004	009SB05193 at NBCH009005	009SB05293 at NBCH009005	009SB06193 at NBCH009006	009SB07193 at NBCH009007	009SB008193 at NBCH009008	RBSL/UTL
Cyanide	ND	ND	ND	ND	ND	ND	ND	ND	1.3UR	160/NV
Cadmium	ND	ND	ND	ND	ND	ND	ND	2.1	0.68	3.9/1.05-1.10
Calcium	62,000	78,000	7,400	250,000	12,000	2200,000	11,000	55,000	38,000	NL/Nutr.
Chromium	35 J	48 J	26 J	11 J	35 J	53 J	19 J	51 J	27 J	39/85.65-83.86
Cobalt	3	3.9	7	2.9	4.6	ND	4.9	4.6	2.6	470/5.863-14.88
Copper	18	65	660	13	140	18	570	230	25 J	290/27.6/31.62
Iron	13,000	14,000	15,000	3,800	9,600	5,400	12,000	9,200	8,200	NL/30,910/66,170
Lead	16 J	23	92 J	10	170 J	7.1 J	110 J	170 J	34 J	400/118-68.69
Magnesium	2,900	3,600	2,800	3,700	2,700	7,600	530	1,700 J	2,200	NL/9,592-9,179
Manganese	140	110	110	220	63	44	61	110	81	39/636.4-1,412
Mercury	0.087	0.12	0.057	0.014	0.08	0.068	0.14	0.15	0.056 J	2.3/0.485-0.74
Nickel	14	13	79	7	45	22	27	43	16	160/33.38-29.90
Potassium	740 J	960	550 J	500	790	1,000	460 J	380 J	480	NL/Nutr.
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	39/2.0-2.7
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	39/NV
Sodium	410	1,500	200	780	930	1,500	97	260	1,300	NL/Nutr.

Table 4.1.5
SWMU 9
1993 Monitoring Well Soil Samples
Inorganic Compounds in Soil (mg/kg)

Element	009SB02193 at NBCH009002	009SB02293 at NBCH009002	009SB03193 at NBCH009003	009SB04193 at NBCH009004	009SB05193 at NBCH009005	009SB05293 at NBCH009005	009SB06193 at NBCH009006	009SB07193 at NBCH009007	009SB008193 at NBCH009008	RBSL/UTL
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.63/0-1.3
Zinc	62	170	520	27	400	55	270	210	57 J	2,300/214.3-129.6
Vanadium	30	41	15	6.6	22	30	38	12	43	55/77.38-131.6
Aluminum	10,000	16,000	4,600	2,100	6,500	5,800	4,000	5,200	7,300	7,900/25,310-46,180
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.1/NV
Arsenic	ND	ND	7.4 J	2.1 J	ND	ND	9.1 J	3.8 J	4.9 J	0.37/14.81-35.52
Barium	42	79	47	15	30	11	79	45	28	550/40.33-43.80
Beryllium	ND	1.4	0.69	ND	0.74	ND	0.84	ND	ND	0.15/1.466-1.62

Table 4.1.6
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Organic Compounds in Shallow Groundwater (µg/L)

Round 1: 21 Samples Collected, 4 Samples Duplicated
Round 2: 17 Samples Collected, 3 Samples Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds					
Acetone	1	2	11.7-44.6	370	Not Listed
	2	2	22-230		
Benzene	1	11	1.8-180	0.35	5
	2	6	2.6-85		
2-Butanone (MEK)	1	1	10.6	190	Not Listed
	2	0	—		
Carbon disulfide	1	2	21.1-80.5	2.1	Not Listed
	2	0	—		
Chlorobenzene	1	9	9-1,300	3.9	100
	2	6	2.1-520		
Chloroethane	1	1	7	860	Not Listed
	2	1	6		
1,2-Dichloroethane	1	1	59	0.12	5
	2	1	58		
1,2-Dichloroethene (total)	1	1	86	5.5	70
	2	1	160		
Ethylbenzene	1	4	3.2-150	130	700
	2	3	20.5-77.5		
4-Methyl-2-Pentanone (MIBK)	1	1	2.8	290	Not Listed
	2	1	10		
Methylene chloride	1	0	—	4.1	5
	2	1	130		
Toluene	1	3	1.5-37	75	1,000
	2	2	7.0-27		
Trichloroethene	1	0	—	1.6	5
	2	1	9		

Table 4.1.6
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Organic Compounds in Shallow Groundwater (μg/L)

Round 1: 21 Samples Collected, 4 Samples Duplicated
Round 2: 17 Samples Collected, 3 Samples Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds					
Trichlorofluoromethane	1	0	—	130	Not Listed
	2	1	52		
Vinyl chloride	1	1	720	0.019	2
	2	1	415		
Xylene (Total)	1	6	3-600	1,200	10,000
	2	4	8-470		
Semivolatile Organic Compounds					
Acenaphthene	1	7	2.9-20	220	Not Listed
	2	3	3.4-16		
Azobenzene	1	1	2.6	0.61	Not Listed
	2	0	—		
Benzidine	1	1	54	0.00029	Not Listed
	2	0	—		
Benzoic acid	1	5	21-69	15,000	Not Listed
	2	0	—		
Butylbenzylphthalate	1	0	—	730	100
	2	1	2.9		
4-Chloro-3-methylphenol	1	2	2.8-3.1	Not Listed	Not Listed
	2	0	—		
bis(2-Chloroethyl)ether	1	1	140	0.0092	Not Listed
	2	0	—		
2-Chlorophenol	1	1	5.6	18	Not Listed
	2	1	8.6		
Di-n-butylphthalate	1	2	2.7-3.4	370	Not Listed
	2	0	—		

Table 4.1.6
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Organic Compounds in Shallow Groundwater (μg/L)

Round 1: 21 Samples Collected, 4 Samples Duplicated
Round 2: 17 Samples Collected, 3 Samples Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Semivolatile Organic Compounds					
Dibenzofuran	1	4	1.2-7.5	15	Not Listed
	2	1	4.7		
1,2-Dichlorobenzene	1	1	4.9	27	600
	2	1	3.55		
1,4-Dichlorobenzene	1	4	3.1-7.5	0.44	75
	2	2	5.6-9.05		
Diethylphthalate	1	1	3.05	2,900	Not Listed
	2	0	—		
2,4-Dimethylphenol	1	4	6.63-1,700	73	Not Listed
	2	3	16-405		
Diphenylamine	1	1	9.6	91.0	Not Listed
	2	0	—		
bis(2-Ethylhexyl)phthalate	1	2	2.4-5.2	4.8	6
	2	0	—		
Fluoranthene	1	2	2.7-3.9	150	Not Listed
	2	1	2.5		
Fluorene	1	5	2.3-7.5	150	Not Listed
	2	0	—		
Hexachlorobenzene	1	0	—	0.0066	1
	2	1	74		
Hexachlorobutadiene	1	0	—	0.12	Not Listed
	2	1	2.8		
Hexachlorocyclopentadiene	1	1	11.0	0.015	50
	2	0	—		
Hexachloroethane	1	0	—	0.61	Not Listed
	2	1	2.7		

Table 4.1.6
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Organic Compounds in Shallow Groundwater (μg/L)

Round 1: 21 Samples Collected, 4 Samples Duplicated
Round 2: 17 Samples Collected, 3 Samples Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Semivolatile Organic Compounds					
2-Methylnaphthalene	1	5	2.2-7.7	150	Not Listed
	2	2	3.05-5.0		
2-Methylphenol (o-cresol)	1	3	3.9-270	180	Not Listed
	2	3	3.3-42		
4-Methylphenol (p-cresol)	1	4	2.1-4,400	18	Not Listed
	2	1	820		
N-nitrosodiphenylamine	1	1	3.4	14.0	Not Listed
	2	0	—		
Naphthalene	1	7	2.2-9.9	150	Not Listed
	2	3	2.5-5.8		
Pentachlorophenol	1	3	11-24	0.6	1
	2	0	—		
Phenanthrene	1	5	2.6-9.8	150	Not Listed
	2	0	—		
Phenol	1	3	6.7-51.8	2,200	Not Listed
	2	2	4.9-6.3		
Pesticides					
4,4'-DDD	1	0	—	0.28	Not Listed
	2	1	0.1		
4,4'-DDE	1	0	—	0.2	Not Listed
	2	1	0.03		
4,4'-DDT	1	1	0.06	0.2	Not Listed
	2	0	—		
Endosulfan I	1	0	—	22	Not Listed
	2	1	0.07		

Table 4.1.6
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Organic Compounds in Shallow Groundwater (μg/L)

Round 1: 21 Samples Collected, 4 Samples Duplicated
Round 2: 17 Samples Collected, 3 Samples Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Herbicides (Round 1: 4 Samples Duplicated)					
2,4,5-T	1	1	0.56	37.0	50
	2	—	No Analysis		
Total Petroleum Hydrocarbons (Round 1: 1 Sample Collected, 2 Samples Duplicated)					
No TPH detected.					
Polychlorinated Biphenyls (Round 1: 21 Samples Collected, 4 Samples Duplicated)					
No PCBs detected.					
Organophosphate Pesticides (Round 1: 4 Samples Duplicated)					
No organophosphates detected.					
Dioxin (Round 1: 4 Samples Duplicated)					
Total TEQs	1	3	0.196-2.502 pg/L	0.5 pg/L	30 pg/L
	2	—	No Analysis		

Table 4.1.7
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Organic Compounds in Deep Groundwater ($\mu g/L$)

Round 1: 8 Samples Collected, 0 Samples Duplicated
Round 2: 8 Samples Collected, 0 Samples Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds					
Chloroform	1	1	2.4	0.15	100
	2	0	—		
Acetone	1	1	25	370	Not Listed
	2	0	—		
Carbon disulfide	1	1	61	2.1	Not Listed
	2	0	—		
Semivolatile Organic Compounds					
Benzoic acid	1	1	2.3	15,000	Not Listed
	2	0	—		
Di-n-butylphthalate	1	1	3.0	370	Not Listed
	2	0	—		
Pesticides					
No pesticides detected.					
Polychlorinated Biphenyls					
No PCBs detected.					

Table 4.1.8
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Inorganic Chemicals in Shallow Groundwater (μg/L)

Round 1: 21 Samples Collected, 4 Samples Duplicated
Round 2: 17 Samples Collected, 3 Samples Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[d]	1 2	4 3	162-1,050 440-1,020	3,700	Not Valid	Not Listed
Antimony[d]	1 2	1 0	18.8 —	1.5	Not Valid	6
Arsenic	1 2	8 9	1.3-11.5 3.8-75	0.038	27.99	50
Barium	1 2	16 10	43.6-1,200 178.5-1,410	260	323	2,000
Beryllium[d]	1 2	0 1	— 1.4	0.016	Not Valid	4
Cadmium[d]	1 2	1 4	1.4 1.3-1.8	1.8	Not Valid	5
Calcium[c]	1 2	21 17	17,900-473,000 15,500-428,000	Not Listed	Nutrient	Not Listed
Chromium[d]	1 2	3 0	4.5-1,460 —	18[e]	Not Valid	100
Cobalt[d]	1 2	3 1	2.4-2.8 2.6	220	Not Valid	Not Listed
Copper[d]	1 2	2 2	6.4-190 7.2-154	140	Not Valid	1,300[f]
Iron	1 2	19 17	743-57,300 172-71,900	Not Listed	45,760	Not Listed
Lead	1 2	9 8	2.4-52.6 1.9-33.5	15[f]	4.697	15[f]
Magnesium	1 2	21 17	3,910-446,000 5,280-655,000	Not Listed	3,866,000	Not Listed
Manganese	1 2	21 17	15.3-1,700 13.6-1,990	18	3,391	Not Listed

Table 4.1.8
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Inorganic Chemicals in Shallow Groundwater (μg/L)

Round 1: 21 Samples Collected, 4 Samples Duplicated
Round 2: 17 Samples Collected, 3 Samples Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Mercury[d]	1 2	1 1	0.55 0.21	1.1	Not Valid	2
Potassium[c]	1 2	21 16	3,400-130,000 15,200-146,000	Not Listed	Nutrient	Not Listed
Selenium	1 2	6 1	0.9-2.1 2.8	18	3.154	50
Silver[d]	1 2	1 0	4.4 —	18	Not Valid	Not Listed
Sodium[c]	1 2	21 17	5,740-4,000,000 24,400-5,460,000	Not Listed	Nutrient	Not Listed
Thallium	1 2	5 0	1-6.4 —	0.29[e]	7.660	2
Vanadium[d]	1 2	9 1	3.3-101 67.9	26	Not Valid	Not Listed
Zinc[d]	1 2	2 0	19.6-19.8 —	1,100	Not Valid	Not Listed
Hexavalent Chromium[d]	1 2	— —	Not Detected No Analysis			100
Cyanide[d]	1 2	— —	Not Detected No Analysis			200

Notes:
(a) = Only elements with detections are listed. Hexavalent chromium and cyanide were separate analyses.
(b) = See Appendix J for UTL determinations.
(c) = Element considered to be a nutrient; therefore, UTL was not determined.
(d) = High percentage of nondetects in background samples prevented determination of UTL.
(e) = Thallium carbonate used as surrogate.
(f) = Based on treatment technique action level.
(g) = If trivalent chromium, RBSL=3,700 μg/L.

Table 4.1.9
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Inorganic Chemicals in Deep Groundwater (μg/L)

Round 1: 8 Samples Collected, 0 Samples Duplicated
Round 2: 8 Samples Collected, 0 Samples Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum	1	3	182-1,580	3,800	723	Not Listed
	2	0	—			
Arsenic	1	4	2.3-4.8	0.038	14.98	50
	2	1	4.1			
Barium	1	5	59.6-176	260	236.9	2,000
	2	0	—			
Cadmium[d]	1	1	2.2	1.8	Not Valid	5
	2	3	2.6-3.2			
Calcium[c]	1	8	92,200-344,000	Not Listed	Nutrient	Not Listed
	2	8	116,000-453,000			
Chromium[d]	1	1	18.1	18[e]	Not Valid	100
	2	0	—			
Cobalt	1	2	2.4-3.0	220	3.165	Not Listed
	2	0	—			
Iron	1	8	1,010-8,590	Not Listed	8,787	Not Listed
	2	7	780-13,600			
Lead	1	4	2.2-6.9	15[f]	4.263	15[f]
	2	0	—			
Magnesium	1	8	559,000-820,000	Not Listed	1,114,000	Not Listed
	2	8	710,000-873,000			
Manganese	1	8	26.6-805	18	776.2	Not Listed
	2	8	16.6-1,270			
Potassium[c]	1	8	153,000-195,000	Not Listed	Nutrient	Not Listed
	2	8	205,000-241,000			
Selenium	1	1	1.0	18	2.103	50
	2	0	—			
Sodium[c]	1	8	4,370,000-6,380,000	Not Listed	Nutrient	Not Listed
	2	8	5,730,000-7,550,000			

Table 4.1.9
SWMUs 9, 19, 20, and 121 and AOCs 649, 650, 651, and 654
Inorganic Chemicals in Deep Groundwater (μg/L)

Round 1: 8 Samples Collected, 0 Samples Duplicated
Round 2: 8 Samples Collected, 0 Samples Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Thallium[d]	1	1	160	0.29[e]	Not Valid	2
	2	0	—			
Vanadium	1	4	4.5-12.2	26	9.29	Not Listed
	2	0	—			
Cyanide[d]	1	1	0.05	73	Not Valid	200
	2	—	No Analysis			

Notes:
[a] = Only elements with detections are listed. Cyanide was a separate analysis.
[b] = See Appendix J for UTL determinations.
[c] = Element considered to be a nutrient; therefore, UTL was not determined.
[d] = High percentage of nondetects in background samples prevented determination of UTL.
[e] = Thallium carbonate used as surrogate.
[f] = Based on treatment technique action level.
[g] = If trivalent chromium, RBSL-3,700 μg/L.

Table 4.1.10
SWMU 9
Organic Compounds Detected in Sediment (in μg/kg)

Compound Name	No. of Detections	Range of Concentrations	Sediment Screening Value
Volatile Organic Compounds ***(15 Samples Collected, 2 Samples Duplicated)***			
Acetone	2	220-350	—
Carbon Disulfide	5	11-150	—
Toluene	2	2.7-4.7	—
Chlorobenzene	1	34	—
Methylene Chloride	1	72	—
2-Butanone	1	42	—
Semivolatile Organic Compounds ***(15 Samples Collected, 2 Samples Duplicated)***			
Fluoranthene	6	61.5-9500	—
Pyrene	6	64.9-6400	380
Benzo(a)anthracene	3	75-140	160
bis(2-Ethylhexyl)phthalate	3	160-830	—
Acenaphthene	1	230	16
Dibenzofuran	1	140	—
Fluorene	1	160	18
Phenanthrene	1	150	140
Chrysene	2	90-140	220
Benzo(b)fluoranthene	3	51.2-119	—
Benzo(k)fluoranthene	2	37.7-78.7	—
Pesticide Compounds ***(15 Samples Collected, 2 Samples Duplicated)***			
Aldrin	3	3.1-18	—
beta-BHC	1	7	—
4-4'-DDT	7	3-140	1
4-4'-DDD	6	4-91	—
4-4'-DDE	11	2-150	—

Table 4.1.10
SWMU 9
Organic Compounds Detected in Sediment (in μg/kg)

Compound Name	No. of Detections	Range of Concentrations	Sediment Screening Value
Pesticide Compounds ***(15 Samples Collected, 2 Samples Duplicated)***			
Alpha-Chlordane	3	2-29	0.5
Gamma-Chlordane	3	1-26	0.5
Chlorobenzilate	1**	71.4	—
Endrin aldehyde	2	3.2-5.8	—
PCB Compounds ***(15 Samples Collected, 2 Samples Duplicated)***			
Aroclor-1254	4	35.3-690	22.7 (total)
Aroclor-1248	1	3,000	22.7 (total)
Aroclor-1260	7	130-890	22.7 (total)
Appendix IX Herbicide Compounds ***(2 Samples Duplicated)***			
2,4-D	1**	47.2	—
Organophosphate Pesticide Compounds ***(2 Samples Duplicated)***			
Parathion	2**	28.6-37.2	—
TPH ***(2 Samples Duplicated)***			
TPH	2	180,000-310,000	—
Dioxin Compounds ***(2 Samples Duplicated)***			
Dioxin	2**	5.045-15.444 pg/g	—
Organotin ***(15 Samples Collected, 2 Duplicated***			
No organotin compounds detected.			

Notes:
— = No reported sediment screening value.
** = Compound analyzed during the duplicate analysis only.

Table 4.1.11
SWMU 9
Inorganic Elements Detected in Sediment (in mg/kg)
(15 Samples Collected, 2 Samples Duplicated)

Element	No. of Detections	Range of Concentrations	Sediment Screening Value
Aluminum	15*	3,830-21,400	—
Copper	15	6.3-228	28
Iron	15*	10,200-66,300	—
Lead	11	5.3-107	21
Potassium	15*	362-2670	—
Sodium	15*	1,090-10,900	—
Antimony	3	2.7-6.9	2
Arsenic	15	0.62-19.6	8
Barium	11	5.3-122	—
Beryllium	15	0.07-1.1	—
Cadmium	9	0.23-1.7	1
Cobalt	15	0.57-5.7	—
Nickel	15	2.8-37.3	20.9
Vanadium	15	4.6-59.8	—
Zinc	15	8.5-387	68
Selenium	9	0.56-2.2	—
Mercury	14	0.02-0.69	0.1
Magnesium	15*	649-7700	—
Manganese	15*	8.8-274	—
Calcium	15*	1,910-220,000	—
Chromium	15	6.5-291	33
Cyanide	1	2	—

Notes:
— = No reported sediment screening value.
* = Compound not analyzed during the duplicate analysis.

Table 4.1.12
SWMU 9
Organic Compounds Detected in Surface Water (in μg/L)

Compound Name	No. of Detections	Range of Concentrations	Chronic Marine Water Quality Criteria
Volatile Organic Compounds *(4 Samples Collected, 0 Samples Duplicated)*			
No VOCs detected			
Semivolatile Organic Compounds *(4 Samples Collected, 0 Samples Duplicated)*			
No SVOCs detected			
Pesticide Compounds *(4 Samples Collected, 0 Samples Duplicated)*			
No pesticide compounds detected			
PCB Compounds *(4 Samples Collected, 0 Samples Duplicated)*			
No PCB compounds detected			
Dioxin Compounds *(1 Sample Duplicated)*			
Dioxin	1	2.246 pg/L	—

Note:
— = No reported chronic marine water quality criteria.

Table 4.1.13
SWMU 9
Inorganic Elements Detected in Surface Water (in μg/L)
(4 Samples Collected, 0 Samples Duplicated)

Compound Name	No. of Detections	Range of Concentrations	Chronic Marine Quality Criteria
Aluminum	4	89.6-19,800	—
Copper	3	40.7-50.8	2.9
Iron	4	1,070-21,900	—
Lead	4	1.7-73	8.5
Potassium	4	5,530-185,000	—
Sodium	4	108,000-4,620,000	—
Thallium	1	6.6	1.7@
Arsenic	4	6.8-14.6	36
Barium	4	15.9-93.2	—
Beryllium	1	0.48	—
Cadmium	1	2.4	9.3
Cobalt	1	4.2	—
Nickel	3	12.7-47.2	8.3
Vanadium	3	24-108	—
Zinc	4	25.1-264	86
Magnesium	4	12,100-552,000	—
Manganese	4	199-329	—
Calcium	4	49,600-299,000	—
Chromium	4	2.8-221	50

Notes:
— = No reported water quality criteria value.
@ = Human Health Risk Value

4.2 SWMU 13

SWMU 13, the current firefighter training area for surface and submarine fleet personnel, has operated since 1973. Diesel fuel and gasoline are ignited during training in a contained, paved, and bermed area. Water and fuel drainage is directed into drains and then into oil-water separators, which drain into the sewer system. Recovered petroleum products are recycled. A underground storage tank (UST) associated with the firefighting training area is in the northwest portion of the SWMU.

Soil and groundwater were sampled at SWMU 13 to determine whether residual contamination resulted from the firefighting training activities or other spills and leaks.

4.2.1 Soil Sampling and Analysis

Soil was sampled in two phases at SWMU 13. During primary soil sampling, 40 soil samples were collected from 23 locations. Twenty-three of the samples were collected from 0 to 1 foot deep and 17 were from the 3- to 5-foot depth interval. Primary sample locations were based on fuel line location, surface runoff drains, fuel storage tank, and active training areas. Soil samples were collected using hand augers as described in Section 2.2.2 and analyzed for VOCs, SVOCs, cyanide, metals, TPH, and pesticides/PCBs. Five of these samples were duplicated and analyzed for herbicides, hexavalent chromium, organophosphate pesticides, and dioxins. Based on the results of the first round duplicate analysis, a second round of samples was collected in the southern and southeastern portion of SWMU 13. These nine additional samples were analyzed for dioxins. Figure 4.2.1 identifies each of the primary and secondary sampling locations. Secondary sample locations were based on analytical results from first-round samples. Analytical results from both rounds of soil sampling are summarized in Tables 4.2.1 (organic) and 4.2.2 (inorganic). Appendix I contains all analytical data for SWMU 13.

4.2.1.1 Volatile Organic Compounds in Soil

VOCs were detected at 18 of the 23 primary sampling locations and in 29 of the 40 samples analyzed. No VOCs were present at concentrations exceeding their respective RBSLs. Of the 29 samples in which VOCs were detected, 18 were collected from the 0- to 1-foot depth interval and 11 were collected from the 3- to 5-foot interval. The concentrations of VOCs ranged from two to seven orders of magnitude below respective RBSLs.

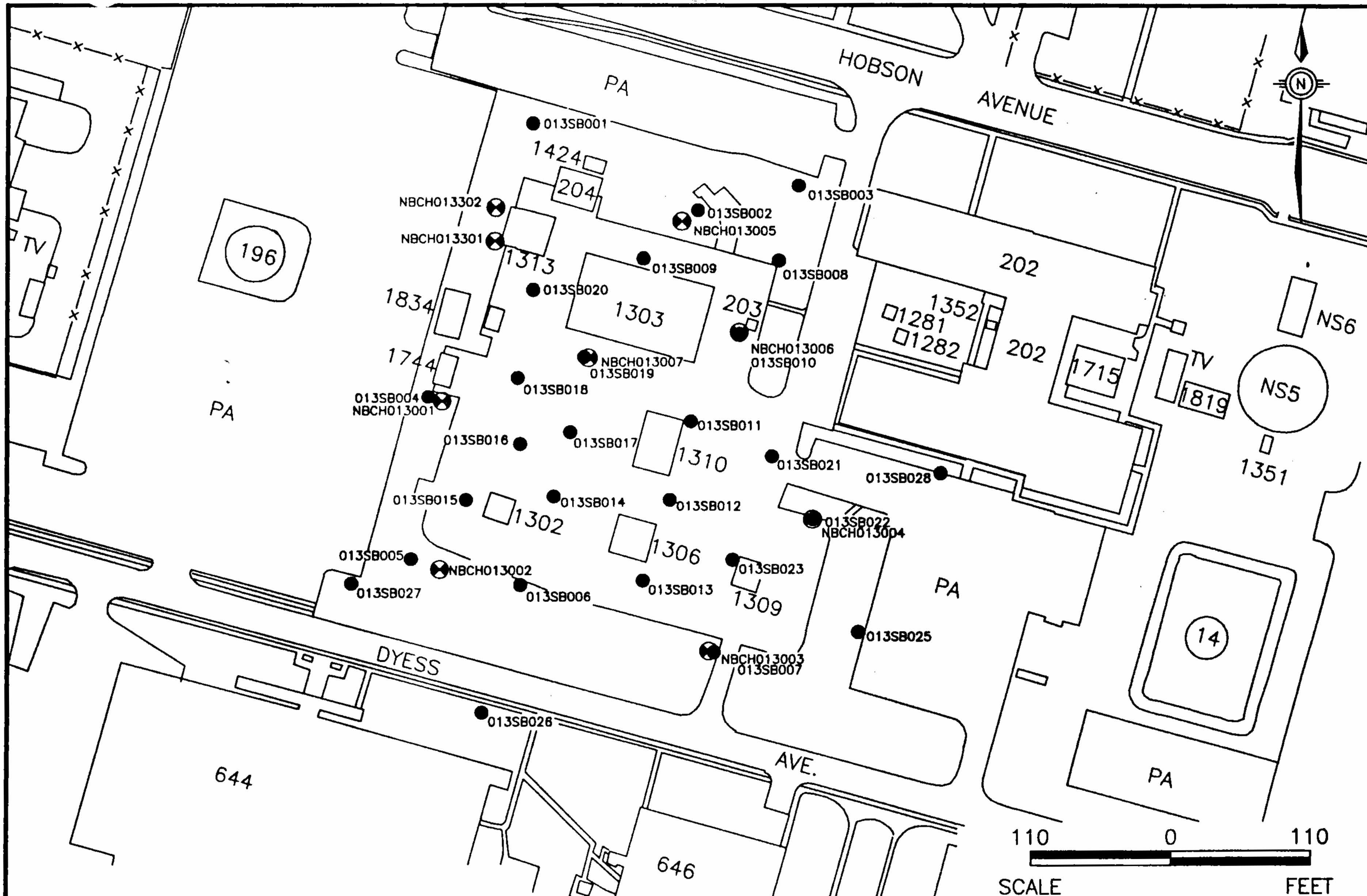
4.2.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected at nine of the 23 primary sampling locations and in nine of the 40 samples analyzed. Of the nine samples in which SVOCs were detected, six were from the 0- to 1-foot depth interval and three were from the 3- to 5-foot interval. Of the 14 different SVOCs detected, all except benzo(a)pyrene and benzo(k)fluoranthene were at least six times lower than their respective RBSLs. Only benzo(a)pyrene was detected at concentrations exceeding the RBSL. Benzo(a)pyrene (RBSL-88 μg/kg) was detected in the 0- to 1-foot interval at locations 013SB005 and 013SB008 at concentrations of 91 μg/kg and 96 μg/kg, respectively. Benzo(k)flouranthene (RBSL-8,800 μg/kg) was detected in the 3- to 5-foot interval of sample location 013SB018 at a concentration of 1,200 μg/kg.

4.2.1.3 Pesticides and PCBs in Soil

Pesticides were detected at 18 of the 23 primary sampling locations and in 21 of the 40 samples analyzed. Of the 21 samples in which pesticides were detected, 18 were collected from the 0-to 1-foot depth interval and three were collected from the 3- to 5-foot interval. Twelve pesticides were detected.

Of the 21 samples in which pesticides were detected, only one sample contained pesticides above the RBSL. The soil sample from the 0- to 1-foot interval at location 013SB019 contained heptachlor (RBSL-140 μg/kg) at a concentration of 390 μg/kg. All other pesticide detections



LEGEND

● – SOIL SAMPLE LOCATION
⊗ – GROUNDWATER SAMPLE LOCATION

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 4.2.1
SWMU 13
SOIL & GROUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 12/06/95	DWG NAME: 29CHZH01

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were below their respective RBSLs. Alpha- and gamma-chlordane (combined RBSL 470 μg/kg), however, were detected in the 3- to 5-foot depth interval at location 013SB019 at a combined concentration of 450 μg/kg. Although the other pesticide compounds which were detected occurred at various locations across the area, they were most consistently detected in the central and southwestern portions of the SWMU.

PCBs were not detected in any soil sample collected from SWMU 13.

4.2.1.4 Other Organic Compounds in Soil

TPH was detected at 11 of the 23 primary sample locations and in 13 of the 40 samples analyzed. Of the 13 samples in which TPH was detected, 10 were collected from the 0- to 1-foot depth interval and three were collected from the 3- to 5-foot interval. TPH concentrations ranged from 75,000 to 15,000,000 μg/kg with concentrations above 100,000 μg/kg in the 0- to 1-foot interval at five locations:

- 013SB004 (110,000 μg/kg)
- 013SB005 (260,000 μg/kg)
- 013SB017 (480,000 μg/kg)
- 013SB018 (730,000 μg/kg)
- 013SB019 (160,000 μg/kg)

TPH concentrations were above 100,000 μg/kg in the 3- to 5-foot interval at three sample locations:

- 013SB003 (2,400,000 μg/kg)
- 013SB018 (15,000,000 μg/kg)
- 013SB019 (180,000 μg/kg)

Silvex (2,4,5-TP) was detected at 8.6 μg/kg and 6.9 μg/kg in the 0- to 1-foot interval at sample locations 013SB006 and 013SB022 and at a concentration of 7.6 μg/kg in the 3- to 5-foot interval at sample location 013SB012. 2,4,5-T was also detected at a concentration of 7.7 μg/kg in the 0- to 1-foot interval at sample location 013SB022. Detected concentrations of both compounds were four orders of magnitude below their respective RBSLs.

Organophosphate pesticides were analyzed in duplicate samples only. No organophosphates were detected in the duplicate soil samples collected at SWMU 13.

Dioxin (screening level 1000 pg/g) was detected in each of 14 soil samples analyzed. TEQ concentrations ranged from 0.507-427.389 pg/g for the upper interval samples and 0.151-22.814 pg/g for the lower interval samples.

4.2.1.5 Inorganic Elements in Soil

Table 4.2.2 summarizes the results of analyses for inorganic elements for soil samples collected at SWMU 13. No elements were detected at concentrations which exceeded both their respective RBSLs and UTLs for background.

Cyanide was detected at two of the 23 primary sampling locations and in three of the 40 samples analyzed. Of the three samples in which cyanide was detected, two were collected from the 0- to 1-foot depth interval at locations 013SB022 and 013SB023 and one was collected from the 3- to 5-foot interval at location 013SB022. The concentrations of cyanide ranged from two to three orders of magnitude below the RBSL.

Hexavalent chromium was analyzed in duplicate samples only. No hexavalent chromium was detected in the four samples submitted for duplicate analysis.

4.2.2 Groundwater Sampling and Analysis

In the first sampling round, nine shallow groundwater monitoring wells were sampled for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH (see Figure 4.2.1). Seven were installed as part of the RFI. Two had been installed before this investigation near a UST in the northwestern area of the site. Based on results from the first round of samples, second-round samples were analyzed for SVOCs, pesticides, and metals. One sample from the second round was duplicated and analyzed for the same parameters as the primary samples. Groundwater was sampled in accordance with procedures detailed in Section 2.4. Analytical data for the groundwater samples are summarized in Tables 4.2.3 (organic) and 4.2.4 (inorganic). Appendix K contains all analytical data for SWMU 13.

4.2.2.1 Volatile Organic Compounds in Groundwater

No VOCs were detected in groundwater samples from the first sampling round.

4.2.2.2 Semivolatile Organic Compounds in Groundwater

Three SVOCs were detected in a first-round groundwater sample from monitoring well NBCH013007. The concentrations for the compounds acenaphthene, phenanthrene, and butylbenzylphthalate were approximately two orders of magnitude lower than their respective RBSLs. No other SVOCs were detected in first-round groundwater samples.

Three SVOCs also were detected in the second-round sample from well NBCH013007. Acenaphthene, fluorene, and 2-methylnaphthene were reported at concentrations far below their corresponding RBSLs. These three compounds were the only SVOCs detected in samples collected during the second round.

4.2.2.3 Pesticides and PCBs in Groundwater

One pesticide compound was detected in a groundwater sample from one well. The pesticide 4,4'-DDT (RBSL-0.2 μg/L) was detected at a concentration of 0.1 μg/L in the first-round sample from NBCH013007. No other pesticides were detected in the groundwater samples collected during the first or second rounds.

No PCBs were detected in first-round samples from monitoring wells. Second-round samples were not analyzed for PCBs.

4.2.2.4 Other Organic Compounds in Groundwater

No petroleum hydrocarbons were detected in first-round groundwater samples. Analysis for petroleum hydrocarbons was not conducted on second-round groundwater samples.

4.2.2.5 Inorganic Elements in Groundwater

The only elements that exceeded their respective RBSLs in groundwater samples from SWMU 13 in the first round were arsenic and manganese. However, concentrations of both elements were below their respective UTLs. The only detection of arsenic (RBSL-0.038 μg/L) was at a concentration of 12.1 μg/L in the sample from well NBCH013001. Manganese exceeded its RBSL of 18 μg/L in eight of the nine first-round samples, ranging up to 925 μg/L from well NBCH013002.

Three elements were detected at concentrations above their RBSLs in second-round samples at SWMU 13. Arsenic was found in three samples, beryllium in one sample, and manganese in all nine samples, with all detections exceeding RBSLs. The arsenic and manganese detections were below their corresponding UTLs. Beryllium did not have enough detections in background samples to allow determination of a valid UTL for that element. Reported arsenic concentrations ranged from 4.1 μg/L in well NBCH0131302 to 7.4 μg/L in NBCH013001. Manganese concentrations ranged from 51.3 μg/L in NBCH013003 to 862 μg/L in NBCH013007. The single beryllium (RBSL-0.016 μg/L) detection of 0.21 μg/L came from well NBCH013005.

No cyanide was detected in the first-round groundwater samples collected at SWMU 13. Cyanide was not analyzed in second-round samples.

4.2.3 Deviations from Final Zone H RFI Work Plan

Forty-two soil samples were proposed to be collected in the Final Zone H RFI Work Plan. The actual number of soil samples collected at SWMU 13 was 49 (28 upper interval, 21 lower interval). Upper interval samples were collected at each proposed location. Due to shallow depth to groundwater, only a portion of the second interval samples were collected from the proposed locations. Based on analytical data for soil samples collected during the initial phase of sampling, additional sample locations were identified. Sampling was attempted in both intervals at each of these additional locations. As with the initial phase of sampling, some of the second-interval samples at the additional sample locations were not collected due to shallow depth to groundwater.

Three sediment samples were proposed to be collected in the Final Zone H RFI Work Plan if the features to be sampled were accessible (Table 4.0.3). No sediment samples were collected. The proposed sample location in the pipeline between the fire-fighting pad and the first oil-water separator was not accessible. Upon inspection of the two oil-water separators there did not appear to be ample substance for sampling; therefore, entry through the separator's grated cover was not attempted.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 presents the quantities of samples proposed and the actual quantity collected at SWMU 13.

Table 4.2.1
SWMU 13
Organic Compounds in Soil (in μg/kg)

Compound Name	Number of Detections (Upper Interval/Lower Interval)	Range of Concentrations for Detections (Upper Interval/Lower Interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(40 Samples Collected — 23 Upper Interval Samples, 17 Lower Interval Samples, 5 Samples Duplicated)***			
Acetone	18/11	25-190 / 23-1,800	780,000
2-Butanone (MEK)	2/1	13-23 / 4.8	4,700,000
Toluene	8/3	3-5 / 3.1-3.2	1,600,000
Xylene (total)	0/2	0 / 5.6-46	16,000,000
Semivolatile Organic Compounds ***(40 Samples Collected — 23 Upper Interval Samples, 17 Lower Interval Samples, 5 Samples Duplicated)***			
Benzo(a)anthracene	2/0	110-120 / 0	880
Benzo(b)fluoranthene	3/0	65-130 / 0	880
Benzo(k)fluoranthene	2/1	84-95 / 12,000	8,800
Benzo(a)pyrene	2/0	91-96 / 0	88
Benzoic acid	0/1	0 / 2,100	31,000,000
Chrysene	2/0	110-140 / 0	88,000
Di-n-butylphthalate	1/0	180 / 0	78,000
Diethylphthalate	1/0	56 / 0	6,300,000
Fluoranthene	4/0	47-290 / 0	310,000
Fluorene	0/1	0 / 3,700	310,000
Hexachlorocyclopentadiene	1/0	430 / 0	55,000
2-Methylnaphthalene	0/2	0 / 140-15,000	310,000
Phenanthrene	3/1	130-240 / 11,000	310,000
Pyrene	5/0	55-230 / 0	230,000
Pesticides ***(40 Samples Collected — 23 Upper Interval Samples, 17 Lower Interval Samples, 5 Samples Duplicated)***			
alpha-BHC	1/0	1 / 0	100
beta-BHC	2/0	1.5-19.5 / 0	350
alpha-Chlordane	5/1	1.4-69 / 130	470 (alpha + gamma)
gamma-Chlordane	5/1	1.5-160 / 320	
4,4'-DDE	18/1	3.0-380 / 3.2	1,900
4,4'-DDD	5/0	5-250/0	2,700
4,4'-DDT	4/0	7-1525 / 0	1,900

Table 4.2.1
SWMU 13
Organic Compounds in Soil (in μg/kg)

Compound Name	Number of Detections (Upper Interval/Lower Interval)	Range of Concentrations for Detections (Upper Interval/Lower Interval)	Risk-Based Screening Levels
Pesticides ***(40 Samples Collected — 23 Upper Interval Samples, 17 Lower Interval Samples, 5 Samples Duplicated)***			
Endosulfan II	1/0	5.1 / 0	47,000
Endrin	0/1	0 / 10	2,300
Endrin aldehyde	1/0	3.4 / 0	2,300
Heptachlor	2/1	5.3-390 / 120	140
Heptachlor epoxide	5/1	4-23 / 32	70
Polychlorinated Biphenyls ***(40 Samples Collected — 23 Upper Interval Samples, 17 Lower Interval Samples, 5 Samples Duplicated)***			
No PCBs detected.			
Petroleum Hydrocarbons ***(40 Samples Collected — 23 Upper Interval Samples, 17 Lower Interval Samples, 5 Samples Duplicated)***			
Total Petroleum Hydrocarbons (IR)	10/3	75,000-730,000 / 180,000-15,000,000	Not Listed
Herbicides ***(5 Duplicate Analyses — 3 Upper Interval Samples, 2 Lower Interval Samples)***			
2,4,5-TP (Silvex)	2/1	6.9-8.6 / 7.6	63,000
2,4,5-T	1/0	7.7 / 0	78,000
Organophosphate Pesticides ***(5 Duplicate Analyses — 3 Upper Interval Samples, 2 Lower Interval Samples)***			
No organophosphate pesticides detected.			
Dioxins ***(14 Samples Collected — 8 Upper Interval Samples, 6 Lower Interval Samples, 2 Samples Duplicated)***			
Total TEQ Values	8/6	0.507-427.389 pg/g (upper) 0.151-22.814 pg/g (lower)	1000 pg/g

Table 4.2.2
SWMU 13
Inorganic Elements in Soil (in mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)		Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	23/17	23/17	554-11,300	504-3,140	7,900	25,310/46,180
Iron[a]	23/17	23/17	1,550-16,400	1,260-5,870	Not Listed	30,910/66,170
Lead	23/17	12/8	5.9-84.7	2.5-49	400	118/68.69
Nickel	23/17	9/9	1.4-22.1	0.48-3	160	33.38/29.90
Potassium[a]	23/17	5/6	180-1,040	109-511	Not Listed	Nutrient[e]
Silver	23/17	0/0	0	0	39	Not Valid[d]
Sodium[a]	23/17	22/17	61.9-414	60-162	Not Listed	Nutrient[e]
Thallium	23/17	0/2	0	0.31-0.33	0.63	0/1.3
Antimony	23/17	1/0	1.9	0	3.1	Not Valid[d]
Arsenic	23/17	11/12	1.6-5.6	0.99-6.1	0.37	14.81/35.52
Barium	23/17	10/9	1.9-36.4	2.3-5.5	550	40.33/43.80
Beryllium	23/17	4/4	0.18-0.67	0.11-0.21	0.15	1.466/1.62
Cadmium	23/17	3/0	0.16-0.19	0	3.9	1.05/1.10
Cobalt	23/17	7/9	0.82-3.3	0.49-1.7	470	5.863/14.88
Copper	23/17	14/5	1.7-49.9	1.1-3.1	290	27.6/31.62
Vanadium	23/17	22/12	4.41-30.4	2.4-11	55	77.38/131.6
Zinc	23/17	14/9	11.25-269	5.8-20.2	2,300	214.3/129.6
Selenium	23/17	1/2	0.6	0.9-0.46	39	2.0/2.7
Mercury	23/17	4/3	0.03-0.08	0.02-0.03	2.3	0.485/.74
Magnesium[a]	23/17	23/17	213-2780	131-931	Not Listed	9,592/9,179
Manganese[a]	23/17	23/17	21.9-218	16.3-67.8	39	636.4/1,412
Calcium	23/17	23/17	3000-312,000	3120-23,500	Not Listed	Nutrient[e]
Chromium	23/17	23/17	2.7-19.7	2.4-8.6	39	85.65/83.86
Tin[a]	3/1	0/0	0	0	4,700	Not Valid[d]
Hexavalent Chromium[b]	3/1	0/0	0	0	39	Not Valid[d]
Cyanide	23/17	2/1	1.0-5.5	0.9	160	Not Valid[d]

Notes:
[a] = Elements that are not included in both SW-846 and Appendix IX methods.
[b] = Included in duplicate sample analyses only.
[c] = See Appendix J for UTL determination.
[d] = Number of nondetections prevented determination of UTLs.
[e] = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.2.3
SWMU 13
Organic Compounds in Groundwater (μg/L)

Round 1: 9 Samples Collected, 0 Samples Duplicated
Round 2: 9 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds (Collected in Round 1 Only)					
No VOCs detected.					
Semivolatile Organic Compounds					
Acenaphthene	1	1	2.4	220	Not Listed
	2	1	2.5		
Butylbenzylphthalate	1	1	2.3	730	100
	2	0	—		
Fluorene	1	0	—	150	Not Listed
	2	1	3.8		
2-Methylnaphthalene	1	0	—	150[a]	Not Listed
	2	1	3.0		
Phenanthrene	1	1	3.6	150[b]	Not Listed
	2	0	—		
Pesticides					
4,4'-DDT	1	1	0.1	0.2	Not Listed
	2	0	—		
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Collected in Round 1 Only)					
No TPH detected.					

Table 4.2.4
SWMU 13
Inorganic Chemicals in Groundwater (μg/L)

Round 1: 9 Samples Collected, 0 Samples Duplicated
Round 2: 9 Samples Collected, 1 Sample Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[d]	1	1	755	3,700	Not Valid	Not Listed
	2	2	22.1-166			
Arsenic	1	1	12.1	0.038	27.99	50
	2	3	4.1-7.4			
Barium	1	0	—	260	323	2,000
	2	8	1.1-20.4			
Beryllium[d]	1	0	—	0.016	Not Valid	4
	2	1	0.21			
Calcium[c]	1	9	79,300-148,000	Not Listed	Nutrient	Not Listed
	2	9	41,200-136,000			
Cobalt[d]	1	0	—	220	Not Valid	Not Listed
	2	1	3.6			
Iron	1	8	188-4,120	Not Listed	45,760	Not Listed
	2	9	95-5,780			
Magnesium	1	9	3,680-78,700	Not Listed	3,866,000	Not Listed
	2	9	5,590-66,700			
Manganese	1	9	12-925	18	3,391	Not Listed
	2	9	51.3-862			
Potassium[c]	1	9	2,940-59,800	Not Listed	Nutrient	Not Listed
	2	9	7,570-63,500			
Selenium	1	0	—	18	3.154	50
	2	2	3.5-5.4			
Sodium[c]	1	9	5,140-318,000	Not Listed	Nutrient	Not Listed
	2	9	14,300-370,000			

Table 4.2.4
SWMU 13
Inorganic Chemicals in Groundwater (μg/L)

Round 1: 9 Samples Collected, 0 Samples Duplicated
Round 2: 9 Samples Collected, 1 Sample Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Vanadium[d]	1	1	13.6	26	Not Valid	Not Listed
	2	0	—			
Zinc[d]	1	0	—	1,100	Not Valid	Not Listed
	2	1	20.4			
Cyanide	1	—	Not Detected			
	2	—	No Analysis			

Notes:
(a) = Only elements with detections are listed. Cyanide was a separate analysis.
(b) = See Appendix J for UTL determinations.
(c) = Element considered to be a nutrient; therefore, UTL was not determined.
(d) = High percentage of nondetects in background samples prevented determination of UTL.

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4.3 SWMU 14 (Includes SWMU 15 and AOCs 670 and 684)

SWMU 14 is an abandoned chemical disposal area where miscellaneous chemicals, warfare decontaminating agents, and possibly industrial wastes were reportedly buried. SWMU 14 area encompasses SWMU 15 and AOCs 670 and 684. The discussion of nature and extent of contamination will include all samples collected in the SWMU 14 area. SWMU 15 is the site of a former propane-fired incinerator reportedly used to destroy classified documents. Only the concrete slab and concrete propane tank saddles remain. AOC 670 is a former outdoor trap and skeet range operated from 1960 until the late 1970s. Lead shot and clay targets were not recovered during its operation. AOC 684 is a former outdoor pistol range in operation from early 1960s until 1981. Firearms were discharged into a soil berm, from which the spent ammunition was not recovered.

A 1992 geophysical and soil-gas investigation (E/A&H, 1994c) investigated the presence of buried containers and/or contaminant plumes in the SWMU 14 area. Portions of the sampling pattern in Figure 4.3.1 were based on geophysical anomalies identified during the geophysical survey. The complete report of findings for the 1992 geophysical and soil-gas investigation is included with this report as Appendix E.

Soil and groundwater were sampled during the most recent investigation to identify whether contamination resulted from chemicals and other waste disposal in the SWMU 14 area and whether residual contamination resulted from firearm discharge in the vicinity.

4.3.1 Soil Sampling and Analysis

Soil was sampled in accordance with procedures detailed in Section 2.2. One hundred and thirty-five (72 upper interval and 63 lower interval) soil samples were collected during the first round of soil sampling near SWMU 14. Sample locations were based on the suspected areas impacted by the former skeet range, the former pistol range, a former paper incinerator, and the general area of the abandoned chemical disposal area. These samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. In addition to the standard suite of analyses, most samples were analyzed for the full Appendix IX group of analytical parameters due to the unknown nature of the types of material disposed in the area.

Appendix IX analyses included herbicides, organophosphate pesticides, hexavalent chromium, and dioxins, as well as more comprehensive lists of VOCs and SVOCs. A grid-based soil sample location is included with the SWMU 14 data due to its proximity.

A second sampling round in the SWMU 14 area involved collecting 25 additional samples (19 upper interval and six lower interval) for analysis of metals, SVOCs, and PCBs.

A third sampling round in the SWMU 14 area involved collecting 16 additional soil samples (eight upper and eight lower) for SVOC analysis.

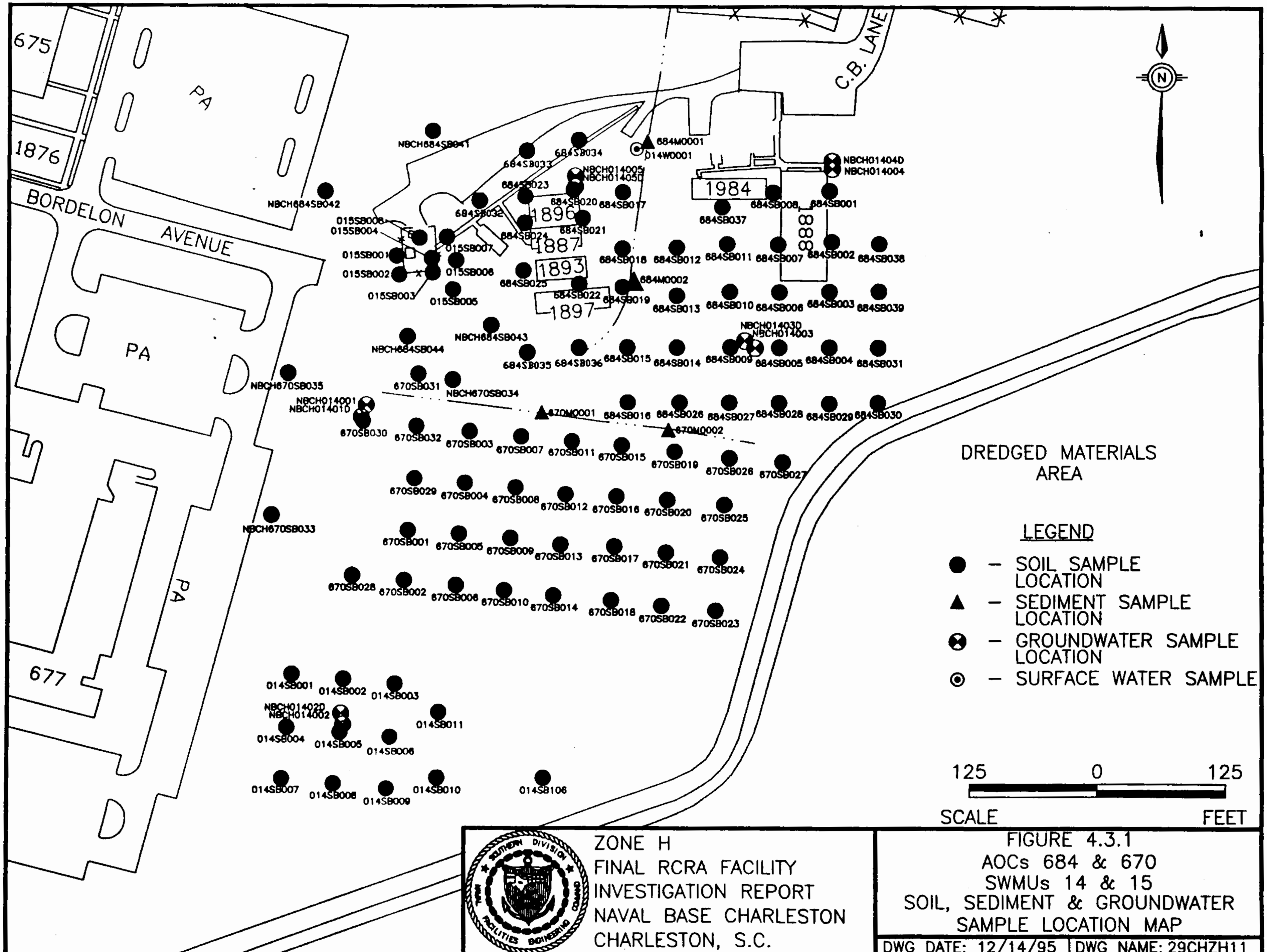
Tables 4.3.1 (organic) and 4.3.2 (inorganic) summarize the analytical data for the soil samples collected near SWMU 14. Figure 4.3.1 identifies all soil and groundwater sampling locations near SWMU 14. Appendix I contains a complete report of the analytical data for the soil samples collected in the SWMU 14 area.

4.3.1.1 Volatile Organic Compounds in Soil

One hundred and thirty-five samples were collected for VOC analysis in the SWMU 14 area. Eleven VOCs were detected in the samples collected in the vicinity of SWMU 14. None of the detections for these compounds exceeded their RBSLs.

4.3.1.2 Semivolatile Organic Compounds in Soil

Twenty-one SVOCs were reported in the soil samples collected in the SWMU 14 area. Six compounds were detected at concentrations which exceeded the RBSLs: (benzo(a)anthracene,



ZONE H
FINAL RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.3.1
AOCs 684 & 670
SWMUs 14 & 15
SOIL, SEDIMENT & GROUNDWATER
SAMPLE LOCATION MAP

DWG DATE: 12/14/95 | DWG NAME: 29CHZH11

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benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene). The highest concentrations were immediately south, southeast, and east of the incinerator pad of SWMU 15, roughly centered on sample location 684SB0035.

4.3.1.3 Pesticides and PCBs in Soil

Seventeen pesticide compounds were detected in the soil samples collected in the SWMU 14 area. None exceeded RBSLs.

Two PCB compounds (Aroclor-1254, and Aroclor-1260) were detected in one sample each from three locations in the northern portion of SWMU 14. Aroclor-1254 (RBSL-83 μg/kg) was detected in samples collected from the 0- to 1-foot interval at sample locations 684SB032 (50 μg/kg) and 684SB033 (160 μg/kg). Aroclor-1260 (RBSL-83 μg/kg) was detected in samples collected from the 0- to 1-foot interval at sample locations 684SB007 (376 μg/kg), 684SBB032 (60 μg/kg), and 684SB033 (71 μg/kg).

4.3.1.4 Other Organic Compounds in Soil

TPH was detected at 24 of the 51 primary sample locations and in 26 of the 90 samples analyzed. Of the 26 samples in which TPH was detected, 12 were from the 0- to 1-foot depth interval and 14 were from the 3- to 5-foot interval. TPH concentrations ranged from 63,000 to 13,400,000 μg/kg, with TPH concentrations above 100,000 μg/kg in 21 of the 28 samples, specifically the 0- to 1-foot interval at sample location 684SB011 (7,700,000 μg/kg) and in the sample collected from the 3 to 5-foot interval at sample location 684SB009 (13,400,000 μg/kg).

Silvex (2,4,5,-TP) (RBSL-63,000 μg/kg) was detected in 24 samples from the 0- to 1-foot interval and in 13 samples from the 3- to 5-foot interval at SWMU 14. Concentrations ranged from 5.6 to 57.5 μg/kg, which are two to three orders of magnitude below respective RBSLs.

2,4,5-T (RBSL-78,000 μg/kg) was detected in 20 samples from the 0- to 1-foot interval and 19 samples from the 3- to 5-foot interval at SWMU 14. Concentrations ranged from 6.5 to 25.1 μg/kg, two to three orders of magnitude below respective RBSLs.

2,4-D (RBSL-78,000 μg/kg) was detected in 16 samples from the 0- to 1-foot interval and eight from the 3- to 5-foot interval at SWMU 14. Concentrations ranged from 35.1 to 68.5 μg/kg, two to three orders of magnitude below respective RBSLs.

One organophosphate pesticide was detected in SWMU 14 soil samples. Parathion (RBSL-47,000 μg/kg) was detected in 14 of the 88 samples analyzed. Detections ranged from 21.3 μg/kg to 37.5 μg/kg, three orders of magnitude below its RBSL.

Dioxin was detected in each of 89 samples analyzed. TEQ concentrations ranged from 0.771-22.357 pg/g for upper interval samples and 0.459-23.560 pg/g for lower interval samples (screening level-1,000 pg/g).

4.3.1.5 Inorganic Elements in Soil

Seven inorganic elements (aluminum, lead, thallium, arsenic, beryllium, vanadium, and chromium) were detected in the soil samples collected near SWMU 14 at concentrations that exceeded their respective RBSLs and interval-specific UTLs. Aluminum was detected in all 50 samples analyzed. It was above both screening limits in only the upper interval at SWMU 14. Lead was detected in 98 of the 133 samples analyzed and was above both screening limits in only the upper interval. The highest lead concentration (20,900 mg/kg) was in a sample from the 0- to 1-foot interval at sampling location 670SB023, within the former trap and skeet range. Thallium was detected in 14 of the 133 samples analyzed and was above both screening limits in only the upper interval. Arsenic was detected in 91 of the 133 samples analyzed and was above both screening limits in only the upper interval. Beryllium was detected in 112 of the 133 samples analyzed and was above both screening limits in only the upper interval. Chromium was detected at concentrations which exceeded both screening levels in only the upper interval.

Cyanide (RBSL-160 mg/kg) was detected in one sample from near SWMU 14. A sample from the 0- to 1-foot interval at location 684SB008 contained cyanide at a concentration of 0.002 mg/kg, five orders of magnitude less than the RBSL.

No hexavalent chromium was detected in the samples collected in near SWMU 14.

4.3.2 Groundwater Sampling and Analysis

Five pairs of monitoring wells were installed to sample the groundwater near SWMU 14 (Figure 4.3.1). A deep monitoring well and a shallow monitoring well were installed at each well pair. The deep monitoring wells were designed to allow groundwater directly above the Ashley Formation to be sampled. The first-round groundwater samples collected for SWMU 14 were analyzed for the entire Appendix IX parameter list due to the unknown nature of the types of material disposed at SWMU 14. One shallow and one deep sample were also analyzed for TPH. Second-round sampling was more narrowly focused. Both shallow and deep samples from the second round were analyzed for VOCs, pesticides, herbicides, and metals. Groundwater sampling adhered to procedures detailed in Section 2.4. Tables 4.3.3 (organic data for shallow monitoring wells), 4.3.4 (organic data for deep wells), 4.3.5 (inorganic data for shallow wells), and 4.3.6 (inorganic data for deep wells) summarize analytical data for groundwater samples collected in the vicinity of SWMU 14. Appendix I presents a complete report of the analytical data for groundwater samples collected near SWMU 14.

4.3.2.1 Volatile Organic Compounds in Groundwater

No VOCs were detected in groundwater samples collected in the first and second sampling rounds from the shallow monitoring wells.

Two VOCs (carbon disulfide, chloroform) were reported for the deep samples collected at SWMU 14 in the first sampling round. Carbon disulfide (RBSL-2.1 μg/L) was detected in deep wells NBCH01402D through NBCH01405D at concentrations ranging from 1.2 μg/L to 3.5 μg/L. Reported concentrations of carbon disulfide equalled or exceeded the RBSL at two wells: NBCH01404D (3.5 μg/L) and NBCH01405D (2.1 μg/L). Chloroform (RBSL-0.15 μg/L) was detected in one deep well. A first-round groundwater sample collected from well NBCH01404D contained chloroform at a concentration of 2.0 μg/L, exceeding the RBSL.

No VOCs were detected in second-round samples from deep wells near SWMU 14.

4.3.2.2 Semivolatile Organic Compounds in Groundwater

The SVOC BEHP (RBSL-4.8 μg/L) was detected in each first-round groundwater sample from the five shallow wells at SWMU 14. Detections for this compound ranged from 1.8 μg/L to 11.8 μg/L and exceeded the RBSL at three of the shallow wells. First-round groundwater samples collected from shallow wells NBCH014002, NBCH014003, and NBCH014004 had BEHP concentrations of 11.8 μg/l, 5.0 μg/L, and 5.8 μg/L, respectively.

BEHP was also detected in the groundwater samples collected in the first round from two of the five deep wells at SWMU 14, and exceeded the RBSL (4.8 μg/L) at one of those wells. First-round samples collected from deep wells NBCH01401D and NBCH01403D contained BEHP at concentrations of 1.7 μg/L and 7.5 μg/L, respectively.

In the second groundwater sampling round, SVOC analysis was not performed on samples from the shallow or deep wells near of SWMU 14.

4.3.2.3 Pesticides and PCBs in Groundwater

No pesticide compounds were detected in the shallow groundwater samples collected in the SWMU 14 area during either sampling round.

Two pesticide compounds (heptachlor epoxide, RBSL-0.0012 μg/L) and isodrin (no RBSL available) were detected in first-round groundwater samples collected from the deep wells at SWMU 14. Heptachlor epoxide was detected at 3.24 μg/L in a groundwater sample collected from deep well NBCH01403D. Isodrin was detected in groundwater samples collected from deep wells NBCH01402D and NBCH01404D at concentrations of 11.3 μg/L and 8.0 μg/L, respectively.

In the second sampling round, no pesticides were detected in groundwater samples from deep wells at SWMU 14.

No PCBs were detected in the shallow or deep groundwater samples collected at SWMU 14 in the first sampling round. PCB analysis was not performed in the second round.

4.3.2.4 Other Organic Compounds in Groundwater

No herbicide compounds were detected in the groundwater samples collected from shallow wells at SWMU 14 in the first sampling round.

Three herbicides were detected in the first-round groundwater samples collected from deep wells at SWMU 14. 2,4-D (RBSL-6.1 μg/L) and 2,4,5-T (RBSL-37 μg/L) were detected in a groundwater sample collected from deep well NBCH01404D at concentrations of 2.4 μg/L and 0.27 μg/L, respectively. 2,4,5-TP (Silvex) (RBSL-29 μg/L) was reported at 0.72 μg/L in a sample from deep well NBCH01405D.

In the second sampling round, the only herbicide detected was 2,4-dichlorophenylacetic acid (DCAA) (no RBSL available), which was in groundwater samples from all 10 wells (five shallow and five deep). Concentrations in samples from the shallow wells ranged from 82 to 103 μg/L, while deep-well sample concentrations ranged from 84 to 117 μg/L.

No organophosphate pesticides were detected in the groundwater samples collected during the first round in the shallow wells at SWMU 14.

One organophosphate pesticide, parathion (RBSL-22 μg/L), was detected in a first-round sample from deep well NBCH01403D at a concentration of 1.0 μg/L. Samples were not analyzed for organophosphate pesticide compounds in the second round.

Dioxin (RBSL-0.5 pg/L) was detected in each of the first-round groundwater samples collected from the five shallow wells at SWMU 14. Dioxin total TEQ concentrations in these samples ranged from 0.214 pg/L to 10.211 pg/L and exceeded the RBSL at four of the wells. Total TEQ concentrations exceeded the RBSL at shallow wells NBCH014001 through NBCH014004 at TEQ concentrations ranging from 1.027 pg/L to 10.211 pg/L.

Dioxin (RBSL-0.5 pg/L) was detected in all first-round groundwater samples collected from the five deep wells at SWMU 14. Dioxin total TEQ concentrations in these samples were 0.122 to 2.152 pg/L, exceeding the RBSL at three wells. Total TEQ concentrations exceeded the RBSL at deep wells NBCH01401D, NBCH01402D, and NBCH01405D at TEQ concentrations of 1.328 pg/L, 2.152 pg/L, and 1.583 pg/L, respectively.

4.3.2.5 Inorganic Elements in Groundwater

Arsenic (RBSL-0.038) was the only inorganic element detected above its RBSL in groundwater samples collected in the first round from shallow groundwater wells at SWMU 14. Arsenic detections in the five shallow wells ranged from 1.0 μg/L to 7.6 μg/L. All reported values were below the UTL for arsenic.

Arsenic, barium, cadmium, and thallium were the only inorganic elements detected above RBSLs in first-round groundwater samples from SWMU 14 deep groundwater wells. Arsenic (RBSL-0.038 μg/L) detections from five deep wells ranged from 1.2 μg/L to 10.2 μ/L. Barium

(RBSL-260 μg/L) was detected in groundwater samples collected from four of the deep wells and exceeded the RBSL in one of those wells. At deep well NBCH01402D, barium was detected at a concentration of 268 μg/L. Cadmium (RBSL-1.8 μg/L) was detected in a groundwater sample collected from deep well NBCH01403D at a concentration of 2.9 μg/L. Thallium (RBSL-0.29 μg/L) was detected in groundwater samples collected from two of the deep wells, NBCH01402D and NBCH01405D, both at a concentration of 1.2 μg/L. All arsenic concentrations were below the UTL for arsenic. The reported concentration of 268 μg/L for the sample from well NBCH01402D was the only barium value to exceed its UTL of 236.9 μg/L. Cadmium and thallium did not have enough detections in background samples determine valid UTLs.

In samples collected from shallow wells during the second round, aluminum, chromium, lead, manganese, and vanadium were detected at concentrations exceeding their corresponding RBSLs. Aluminum (RBSL-3,700 μg/L) was reported in samples from three wells, and its concentration exceeded its RBSL at one of them: 15,500 μg/L at NBCH014001. Chromium (RBSL-18), lead (RBSL-15 μg/L), and vanadium (RBSL-26 μg/L) were detected only in the sample from well NBCH014001 at concentrations of 44.4 μg/L, 19.7 μg/L, and 65.2 μg/L, respectively. [*Note:* The chromium RBSL of 18 μg/L is based on hexavalent chromium, which has not been detected in any sample in Zone H. The RBSL for trivalent chromium in tap water is 3700 μg/L.] Manganese (RBSL-18 μg/L) was in second-round samples from all five shallow wells, at concentrations ranging from 77.2 to 2,350 μg/L. The single detection of lead in second-round shallow samples was above lead's UTL of 4.697 μg/L. Manganese concentrations were all lower than the UTL for manganese. Aluminum, chromium, and vanadium were not detected in enough background samples to determine valid UTLs for those metals.

Arsenic, cadmium, and manganese were detected at concentrations above their corresponding RBSLs in second-round groundwater samples collected from deep wells at SWMU 14. Arsenic exceeded its RBSL at one well, cadmium at three wells, and manganese at all five deep wells.

Arsenic (RBSL-0.037 μg/L) was reported at a concentration of 5.5 μg/L from well NBCH01403D. Cadmium (RBSL-1.8 μg/L) was detected at 1.8, 2.9, and 2.0 μg/L in samples from wells NBCH01402D-04D, respectively. Reported manganese concentrations ranged from 10.15 μg/L in well NBCH01403D to 109 μg/L in well NBCH01405D. Arsenic and manganese concentrations were all below their corresponding UTLs. Cadmium was not detected in enough background samples to determine a valid UTL.

Hexavalent chromium and cyanide were not detected in first-round samples collected from shallow and deep wells in the of SWMU 14 area. Second-round samples were not analyzed for these chemicals.

4.3.3 Sediment Sampling and Analysis

Four sediment samples were collected to measure the potential impact from SWMU 14 and other adjacent SWMUs. All sediment samples were collected from 0 to 1 foot below the sediment surface.

Concentrations of contaminants detected in the sediment were compared to USEPA Region IV SSV. These values are shown on the accompanying tables and are intended to be only a screening level comparison to determine the need for further study. The SSVs and how they relate to ecological risk will be discussed further in the Zone J RFI report.

The four samples were analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, herbicides, organophosphate pesticides, cyanide, metals, hexavalent chromium, and dioxin. Sediment sampling locations were based on areas most likely to have been impacted by a potential release from SWMU 14, AOC 670, AOC 684, or any other nearby SWMU. Sediment sample analytical results are summarized in Table 4.3.7 (organic) and Table 4.3.8 (inorganic).

4.3.3.1 Volatile Organic Compounds in Sediment

Eleven VOCs were detected in all four samples analyzed. None had a corresponding SSV.

4.3.3.2 Semivolatile Organic Compounds in Sediment

Sixteen SVOCs were detected in all four sample locations. Acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluorene, phenanthrene, and pyrene were detected above SSVs at two sample locations. The sediment sample collected at location 670M0001 contained each of these SVOCs at concentrations above their respective SSVs. A sediment sample collected at location 684M0001 contained pyrene and chrysene above SSVs.

Benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, dibenzofuran, fluoranthene, and indeno(1,2,3-cd)pyrene were detected in one or more of the four sediment samples but do not have currently listed SSVs.

4.3.3.3 Pesticides and PCBs in Sediment

Eight pesticides were detected in three of the four sample locations. Of the eight pesticide detections, only DDT and chlordane have SSVs. Chlordane (alpha and/or gamma) (SSV 0.5 μg/kg) was detected in sediment samples from locations 670M0001, 684M0001, and 684M0002 at concentrations ranging from 2.3 μg/kg to 98.1 μg/kg. 4,4'-DDT (SSV 1.0 μg/kg) was also detected in sediment samples collected from these three locations at concentrations ranging from 6.2 μg/kg to 25.3 μg/kg.

PCBs were not detected in any of the four sediment samples collected.

4.3.3.4 Other Organic Compounds in Sediment

Of the four samples analyzed for herbicides, 2,4,5-T was detected in two of the samples and 2,4-D was detected in two of the samples. 2,4,5-T was detected in sediment samples collected at locations 670M0001 and 684M0002 at concentrations of 14.4 μg/kg and 19.8 μg/kg, respectively. 2,4-D was detected in sediment samples collected at locations 684M0001 and 684M0002 at concentrations of 116 μg/kg and 97.1 μg/kg, respectively. Neither of these compounds has a listed SSV.

Organophosphate pesticides were not detected in any of the four sediment samples.

TPH was detected in two of the four sediment samples collected. TPH was detected in sediment samples collected from locations 684M0001 and 684M0002 at concentrations of 2,100,000 μg/kg and 780,000 μg/kg, respectively. TPH has no SSV.

Dioxins (no SSV listed) were detected in each the four sediment samples at concentrations ranging from 5.133 pg/g to 67.623 pg/g.

Organotin compounds were not detected in any of the sample locations.

4.3.3.5 Inorganic Elements in Sediment

At least one inorganic element exceeded its SSV at all four sample locations. Elements which exceeded their SSVs most frequently were chromium, arsenic, and zinc. Chromium (SSV 33.0 mg/kg) was detected in each of the four sediment samples collected at concentrations ranging from 37.9 mg/kg to 45.8 mg/kg. Arsenic (SSV 8.0 mg/kg) was detected in sediment samples 670M0001, 684M0001, and 684M0002 at concentrations ranging from 8.9 mg/kg to 20.3 mg/kg. Zinc (SSV 68 mg/kg) was detected in sediment samples collected from locations 670M0001, 684M0002, and 684M0002 at concentrations ranging from 89.8 mg/kg to 136 mg/kg.

Cyanide was not detected in any of the four sediment samples collected.

Hexavalent chromium was not detected in any of the four sediment samples collected.

4.3.4 Surface Water Data

One surface water sample was collected from a nearby water body to measure the potential impact from adjacent SWMUs. The surface water sample was collected from 0 to 1 foot below the water surface.

Detections in the surface water were compared to USEPA chronic marine surface water quality criteria. These values are shown on the accompanying tables and are intended to be only a screening level comparison to determine the need for further study. Water quality criteria and how they relate to ecological risk will be discussed further in the Zone J RFI report.

One surface water sample was collected at location 014W0001 and analyzed for VOCs, SVOCs, pesticides/PCBs, herbicides, organophosphate pesticides, cyanide, metals, hexavalent chromium, and dioxins. The position of the surface water sampling location was based on the area most likely to have been impacted by a potential release from SWMU 14 or any other nearby SWMU. Analytical results for surface water samples are summarized in Table 4.3.9 (organic) and Table 4.3.10 (inorganic).

4.3.4.1 Volatile Organic Compounds in Surface Water

VOCs were not detected in the surface water sample collected.

4.3.4.2 Semivolatile Organic Compounds in Surface Water

SVOCs were not detected in the surface water sample collected.

4.3.4.3 Pesticides and PCBs in Surface Water

Pesticides and PCBs were not detected in the surface water sample collected.

4.3.4.4 Other Organic Compounds in Surface Water

One herbicide, 2,4,5-TP (Silvex), was detected in the surface water sample at a concentration of 0.34 μg/L. Silvex does not have a water quality criteria value listed.

Organophosphate pesticides were not detected in the one surface water sample.

Dioxin was detected in the surface water sample at a concentration of 7.327 pg/L. There is currently no surface water quality criteria listed for dioxin.

Organotin compounds were not detected in the surface water sample collected.

4.3.4.5 Inorganic Elements in Surface Water

Lead, mercury, nickel, and arsenic exceeded their chronic marine water quality criteria in the surface water sample collected (see Table 4.3.10).

Hexavalent chromium was not detected in the surface water sample.

Cyanide was not detected in the surface water sample.

4.3.5 Deviations from Final Zone H RFI Work Plan

One hundred and forty-four (72 upper and 72 lower) soil samples were proposed to be collected from SWMU 14 in the Final Zone H RFI Work Plan. The actual number of soil samples collected within the SWMU 14-associated sites is 176 (99 upper interval and 77 lower interval). The upper interval was sampled at each proposed location. Due to shallow depth to groundwater, only some of the second interval samples were collected from the proposed 72 locations. Based on analytical data for soil samples collected during the initial phase of sampling, additional sample locations were identified. Sampling was attempted at both intervals at each of these additional locations. As with the initial phase of sampling, some of the second-interval samples at the additional locations were not collected due to shallow depth to groundwater.

One sediment sample was proposed for collection in the Final Zone H RFI Work Plan. Four sediment samples were collected. During field sampling, two converging ditches were identified. Two samples from each of these ditches were collected.

A surface water sample was collected from the sample location proposed in the Final Zone H RFI Work Plan.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 presents the quantities of samples proposed and actual quantities collected from the SWMU 9-associated sites.

Table 4.3.1
SWMUs 14 and 15, and AOC 670 and 684
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st Interval/2nd Interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(135 Samples Collected — 72 Upper Interval Samples, 63 Lower Interval Samples, 6 Samples Duplicated)***			
Acetone	10/25	7.6-97.4/34-284	780,000
Carbon disulfide	3/3	1.2-3.5/2.4-4.6	780,000
1,1-Dichloroethene	3/4	1.8-2.5/1.8-4.8	1,100
Methylene chloride	13/12	11-212/11-51	85,000
2-Butanone (MEK)	2/7	3.9-4.6/2.7-15.5	4,700,000
Tetrachloroethene	1/0	1.4/0	12,000
Toluene	47/24	1.9-143/1.9-66	1,600,000
Trichloroethene	0/2	0/2.0-2.9	47,000
Xylene (total)	23/11	1.4-9.3/1.3-8.9	16,000,000
Acetonitrile[a]	0/3	0/5-7.3	47,000
1,2,3-Trichloropropane[a]	1/0	91.2/0	240
Semivolatile Organic Compounds ***(172 Samples Collected — 96 Upper Interval Samples, 76 Lower Interval Samples, 6 Samples Duplicated)***			
Acenaphthene	19/0	28.7-2,800/0	470,000
Acenaphthylene	1/0	286/0	470,000
Anthracene	21/1	14.3-4,400/37.2	2,300,000
Benzo(a)anthracene	46/7	34.5-20,000/39.7-140	880
Benzo(b)fluoranthene	43/5	50.4-16,000/104-200	880
Benzo(k)fluoranthene	41/5	48.1-26,500/83.4-140	8,800
Benzo(g,h,i)perylene	32/0	72-5,520/0	310,000
Benzo(a)pyrene	46/4	53.1-22,000/71.5-150	88

Table 4.3.1
SWMUs 14 and 15, and AOC 670 and 684
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st Interval/2nd Interval)	Risk-Based Screening Levels
Semivolatile Organic Compounds *(172 Samples Collected — 96 Upper Interval Samples, 76 Lower Interval Samples, 6 Samples Duplicated)*			
bis(2-Ethylhexyl)phthalate (BEHP)	17/9	45.7-800/48.1-5,670	46,000
Chrysene	49/8	46.4-21,000/56-180	88,000
Dibenzo(a,h)anthracene	20/0	62-3,640/0	88
Dibenzofuran	8/0	54.7-1,000/0	31,000
Di-n-butylphthalate	0/1	0/65.3	780,000
Fluoranthene	52/16	44.8-45,000/46.4-284	310,000
Fluorene	10/0	55-1,500/0	310,000
Hexachlorobutadiene	0/1	0/86	1,600
Indeno(1,2,3-cd)pyrene	31/0	74-17,000/0	880
2-Methylnaphthalene	4/0	44.6-524/0	310,000
Naphthalene	7/0	75.8-1,070/0	310,000
Phenanthrene	38/1	49.2-33,500/6.4	310,000
Pyrene	52/18	42.3-41,800/48.7-281	230,000
Pesticides *(136 Samples Collected — 74 Upper Interval Samples, 62 Lower Interval Samples, 6 Samples Duplicated)*			
alpha-BHC	1/0	1.4/0	100
beta-BHC	0/1	0/2.0	350
delta-BHC	3/3	1.2-1.7/1.3-2.8	490
alpha-Chlordane	10/1	1.2-24.7/48.1	470 (alpha + gamma)

Table 4.3.1
SWMUs 14 and 15, and AOC 670 and 684
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st Interval/2nd Interval)	Risk-Based Screening Levels
Pesticides *(136 Samples Collected — 74 Upper Interval Samples, 62 Lower Interval Samples, 6 Samples Duplicated)*			
gamma-Chlordane	7/2	1.7-52.5/2-86.9	
4,4'-DDD	9/22	2.4-12.2/2.9-211	2,700
4,4'-DDE	19/17	2-19.7/2-7.8	1,900
4,4'-DDT	26/2	2.4-50/3.3-5	1,900
Dieldrin	5/0	2.4-10/0	40
Endosulfan I	2/0	1.4-1.8/0	47,000
Endosulfan II	4/0	2.5-6.2/0	47,000
Endrin	4/0	2.2-5.6/0	2,300
Endrin aldehyde	6/1	2.2-22/3.6	2,300
Heptachlor	2/1	1.1-1.3/1.6	140
Heptachlor epoxide	7/0	1.4-17.8/0	70
Chlorobenzilate[a]	3/0	25.6-160/0	2,400
Isodrin[a]	2/3	3.2-3.3/3.3-3.8	Not Listed
Polychlorinated Biphenyls *(147 Samples Collected — 81 Upper Interval Samples, 66 Lower Interval Samples, 5 Samples Duplicated)*			
Aroclor-1254	2/0	50-160/0	83
Aroclor-1260	3/0	60-376/0	83
Total Petroleum Hydrocarbons *(90 Samples Collected — 52 Upper Interval Samples, 38 Lower Interval Samples, 2 Samples Duplicated)*			
Total Petroleum Hydrocarbons	12/14	63,000-7,700,000/79,000-13,400,000	Not Listed

Table 4.3.1
SWMUs 14 and 15, and AOC 670 and 684
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st Interval/2nd Interval)	Risk-Based Screening Levels
Herbicides *(88 Samples Collected — 51 Upper Interval Samples, 37 Lower Interval Samples, 2 Samples Duplicated)*			
2,4,5-TP (Silvex)	24/13	5.6-26.3/7.7-57.5	63,000
2,4,5-T	20/19	6.5-18.6/7.0-25.1	78,000
2,4-D	16/8	35.1-68.5/46.1-66.2	78,000
Organophosphate Pesticides *(88 Samples Collected — 51 Upper Interval Samples, 37 Lower Interval Samples, 2 Samples Duplicated)*			
Parathion	9/5	21.3-37.5/23.3-35.9	47,000
Dioxins *(89 Samples Collected — 52 Upper Interval Samples, 37 Lower Interval Samples)*			
Total TEQ	52/37	0.771-22.357 pg/g 0.459-23.560 pg/g	1000 pg/g

Note:
[a] = Compound included in the Appendix IX analysis but not in the SW-846 analysis.

Table 4.3.2
SWMUs 14 and 15, AOCs 670 and 684
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	27/24	27/24	2,600-29,600/11,100-31,200	7,900	25,310/46,180
Iron[a]	27/24	27/24	4,360-31,800/18,100-45,400	Not Listed	30,910/66,170
Lead	77/62	57/46	3.96-20,900/2.97-47.4	400	118/68.69
Nickel	77/62	51/37	4.1-29.0/3.5-23.4	160	33.38/29.9
Potassium[a]	27/24	26/24	711-2,410/1,420-2,550	Not Listed	Nutrient[e]
Silver	77/62	0/0	0/0	39	Not Valid[d]
Sodium[a]	27/24	27/24	153-1,030/285-2,130	Not Listed	Nutrient[e]
Thallium	77/62	10/4	0.073-2.9/0.07-0.86	0.63	0.63/1.3
Antimony	77/62	8/9	42.0-12.4/2.3-8.7	3.1	Not Valid[d]
Arsenic	77/62	52/43	0.89-69/2.0-29.4	0.37	14.81/35.2
Barium	77/62	40/51	2.9-121/8.2-42.6	550	40.33/43.8
Beryllium	77/62	65/49	0.13-1.51/0.18-1.5	0.15	1.466/1.62
Cadmium	77/62	23/6	0.29-3.6/0.22-2.03	3.9	1.05/1.1
Cobalt	77/62	37/32	1.1-6.6/1.5-9.2	470	5.863/14.88
Copper	77/62	58/45	3.7-79.7/3.4-28.2	290	27.6/31.62
Vanadium	77/62	76/60	7.9-72/9.1-84.4	55	77.38/131.6
Zinc	77/62	60/48	5.1-180/7.7-98.9	2,300	214.3/129.6
Selenium	77/62	51/49	0.13-6.2/0.13-3.5	39	2.0/2.7
Mercury	77/62	48/42	0.02-0.24/0.05-0.86	2.3	0.485/.74
Magnesium[a]	27/24	27/24	3,350-7,520/3,540-5,440	Not Listed	9,592/9,179
Manganese[a]	27/24	27/24	42.4-506/176-893	1,092	636.4/1,412
Calcium	27/24	27/24	59,000-275,000/6,250-83,500	Not Listed	Nutrient[e]
Chromium	76/62	77/62	3.6-91/3.6-64.9	39	85.65/83.86
Tin[a]	52/38	3/4	32.8-81/2.3-60.1	4,700	Not Valid[d]
Hexavalent Chromium[b]	52/38	0/0	0/0	39	Not Valid[d]
Cyanide	77/62	1/0	.002/0	160	Not Valid[d]

Notes:

(a) = Elements that are not included in both SW-846 and Appendix IX methods
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTL.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.3.3
SWMUs 14 and 15, and AOCs 670 and 684
Organic Compounds in Shallow Groundwater (μg/L)

Round 1: 5 Samples Collected, 0 Samples Duplicated
Round 2: 5 Samples Collected, 0 Samples Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds					
No VOCs detected					
Semivolatile Organic Compounds (Collected in Round 1 Only)					
bis(2-Ethylhexyl)phthalate	1	5	1.8-11.8	4.8	6
	2	—	No Analysis		
Pesticides					
No pesticides detected.					
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Herbicides					
DCAA	1	0	—	Not Listed	Not Listed
	2	5	82-103		
Organophosphate Pesticides (Collected in Round 1 Only)					
No organophosphate pesticides detected.					
Dioxins (Collected in Round 1 Only)					
Total TEQs	1	5	0.214-10.211 pg/L	0.5 pg/L	30 pg/L
	2	—	No Analysis		

Table 4.3.4
SWMUs 14, and 15, and AOCs 670 and 684
Organic Compounds in Deep Groundwater ($\mu g/L$)

Round 1: 5 Samples Collected, 1 Sample Duplicated
Round 2: 5 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds					
Carbon disulfide	1	4	1.2-3.5	2.1	Not Listed
	2	0	—		
Chloroform	1	1	2.0	0.15	100
	2	0	—		
Semivolatile Organic Compounds (Collected in Round 1 Only)					
bis(2-Ethylhexyl)phthalate	1	2	1.7-7.5	4.8	6
(BEHP)	2	—	No Analysis		
Pesticides					
Heptachlor epoxide	1	1	3.24	0.0012	0.2
	2	0	—		
Isodrin	1	2	8.0-11.3	Not Listed	Not Listed
	2	0	—		
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Herbicides					
2,4-D (1 Sample Collected)	1	1	2.4	6.1	70
(5 Samples Collected)	2	0	—		
2,4,5-T	1	1	0.27	37	50
	2	1	1.5		
2,4,5-TP (Silvex)	1	1	0.72	29	50
	2	0	—		
DCAA	1	—	No Analysis	Not Listed	Not Listed
	2	5	84-117		
Organophosphate Pesticides (Collected in Round 1 Only)					
Parathion	1	1	1.0	22	Not Listed
	2	—	No Analysis		
Dioxins (Collected in Round 1 Only)					
Total TEQ	1	5	0.122-2.152 pg/L	0.5 pg/L	30pg/L
	2	—	No Analysis		

Table 4.3.5
SWMUs 14 and 15, and AOCs 670 and 684
Inorganic Chemicals in Shallow Groundwater (μg/L)

Round 1: 5 Samples Collected, 0 Samples Duplicated
Round 2: 5 Samples Collected, 0 Samples Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[d]	1	—	No Analysis	3,700	Not Valid	Not Listed
	2	3	462-15,500			
Arsenic	1	5	1.0-7.6	0.038	27.99	50
	2	0	—			
Barium	1	2	84.3-166	260	323	2,000
	2	3	44.2-58.4			
Calcium[e]	1	—	No Analysis	Not Listed	Nutrient	Not Listed
	2	5	74,600-252,000			
Chromium[d]	1	0	—	18[f]	Not Valid	100
	2	1	44.4			
Iron	1	—	No Analysis	Not Listed	45,760	Not Listed
	2	5	2,130-38,400			
Lead	1	5	1.3-5.0	15[c]	4.697	15[c]
	2	1	19.7			
Magnesium	1	—	No Analysis	Not Listed	3,866,000	Not Listed
	2	5	119,000-190,000			
Manganese	1	—	No Analysis	18	3,391	Not Listed
	2	5	77.2-2,350			
Potassium[e]	1	—	No Analysis	Not Listed	Nutrient	Not Listed
	2	5	38,000-66,000			
Selenium	1	3	1.2-1.6	18	3.154	50
	2	0	—			
Sodium[e]	1	—	No Analysis	Not Listed	Nutrient	Not Listed
	2	5	596,000-1,270,000			
Vanadium[d]	1	0	—	26	Not Valid	Not Listed
	2	1	65.2			
Zinc[d]	1	0	—	1,100	Not Valid	Not Listed
	2	1	82.8			
Hexavalent Chromium	1		Not Detected			
	2		No Analysis			
Cyanide	1		Not Detected			
	2		No Analysis			

Notes:
(a) = Only elements with detections are listed. Hexavalent chromium and cyanide were separate analyses.
(b) = See Appendix G for UTL determinations.
(c) = Based on treatment technique AL.
(d) = High percentage of nondetects prevented determination of UTL.
(e) = Element considered to be a nutrient; therefore, UTL was not determined.
(f) = If trivalent chromium, RBSL-3,700 μg/L.

Table 4.3.6
SWMUs 14 and 15, and AOCs 670 and 684
Inorganic Chemicals in Deep Groundwater (µg/L)

Round 1: 5 Samples Collected, 1 Sample Duplicated
Round 2: 5 Samples Collected, 1 Sample Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Arsenic	1	5	1.2-10.2	0.038	14.98	50
	2	1	5.5			
Barium	1	4	89.1-268	260	236.9	2,000
	2	5	62.1-246			
Cadmium[d]	1	1	2.9	1.8	Not Valid	5
	2	3	1.8-2.9			
Calcium[f]	1	—	No Analysis	Not Listed	Nutrient	Not Listed
	2	5	169,000-221,000			
Iron	1	—	No Analysis	Not Listed	8,787	Not Listed
	2	2	191-408			
Lead	1	3	1.3-8.3	15[c]	4.263	15[c]
	2	0	—			
Magnesium	1	—	No Analysis	Not Listed	1,114,000	Not Listed
	2	5	869,000-1,195,000			
Manganese	1	—	No Analysis	18	776.2	Not Listed
	2	5	10.15-109			
Potassium[f]	1	—	No Analysis	Not Listed	Nutrient	Not Listed
	2	5	222,000-284,000			
Selenium	1	4	1.1-1.7	18	2.103	50
	2	0	—			
Sodium[f]	1	—	No Analysis	Not Listed	Nutrient	Not Listed
	2	5	-8,025,000			
Thallium[d]	1	2	1.2-1.2	0.29[e]	Not Valid	2
	2	0	—			
Hexavalent Chromium	1	—	Not Detected			
	2	—	No Analysis			
Cyanide	1	—	Not Detected			
	2	—	No Analysis			

Notes:

(a) = Only elements with detections are listed. Hexavalent chromium and cyanide were separate analyses.
(b) = See Appendix J for UTL determinations.
(c) = Based on treatment technique AL.
(d) = High percentage of nondetects in background samples prevented determination of UTL.
(e) = Thallium carbonate used as surrogate.
(f) = Element considered to be a nutrient; therefore, UTL was not determined.

Table 4.3.7
SWMU 14
Organic Compounds Detected in Sediment (μg/kg)

Compound Name	No. of Detections	Range of Concentrations	Sediment Screening Value
Volatile Organic Compounds ***(4 Samples Collected, 0 Samples Duplicated)***			
Acetone	2	156-361	—
Carbon Disulfide	2	4-5	—
Toluene	2	3.6-8.2	—
Methylene Chloride	1	172	—
2-Butanone	2	17.8-36.7	—
1,1-Dichloroethene	1	3.2	—
Tetrachloroethene	1	87.1	—
Trichloroethene	1	37	—
1,2,3-Trichloropropane	1	12.2	—
Vinyl Chloride	1	17.8	—
Xylene	2	1.7-2.8	—
Semivolatile Organic Compounds ***(4 Samples Collected, 0 Samples Duplicated)***			
Fluoranthene	4	51.4-12800	—
Pyrene	3	197-11800	380
Benzo(a)anthracene	2	126-7900	160
bis(2-Ethylhexyl)phthalate	1	156	—
Acenaphthene	1	1330	16
Dibenzofuran	1	472	—
Fluorene	1	842	18
Phenanthrene	2	157-7840	140
Chrysene	3	82.7-8490	220
Benzo(b)fluoranthene	4	51.4-9940	—
Anthracene	1	1770	85
Benzo(k)fluoranthene	3	103-8390	—
Benzo(g,h,i)perylene	1	6510	—

Table 4.3.7
SWMU 14
Organic Compounds Detected in Sediment (μg/kg)

Compound Name	No. of Detections	Range of Concentrations	Sediment Screening Value
Semivolatile Organic Compounds *(4 Samples Collected, 0 Samples Duplicated)*			
Benzo(a)pyrene	4	50-12100	230
Dibenzo(a,h)anthracene	1	3000	31
Indeno(1,2,3-cd)pyrene	1	7040	—
Pesticide Compounds *(4 Samples Collected, 0 Samples Duplicated)*			
beta-BHC	2	2.6-3.2	—
4-4'-DDT	3	6.2-25.3	1
4-4'-DDD	3	3.6-338	—
4-4'-DDE	2	39-89.2	—
alpha-Chlordane	3	2.3-58.7	0.5
gamma-Chlordane	2	92.3-98.1	0.5
Appendix IX Herbicide Compounds *(4 Samples Collected, 0 Samples Duplicated)*			
2,4,5-T	2	14.4-19.8	—
2,4-D	2	97.1-116	—
TPH *(4 Samples Collected, 0 Samples Duplicated)*			
TPH	2	780,000-2,100,000	—
Dioxin Compounds *(4 Samples Collected, 0 Samples Duplicated)*			
Dioxin	4	5.133-67.623 (picograms/gram)	—

Note:
— = No reported sediment screening value.

Table 4.3.8
SWMU 14
Inorganic Elements Detected in Sediment (mg/kg)
(4 Samples Collected, 0 Samples Duplicated)

Compound Name	No. of Detections	Range of Concentrations	Sediment Screening Value
Copper	4	10.8-50.8	28
Lead	2	112-148	21
Arsenic	4	5.5-20.3	8
Barium	2	24.5-32.5	—
Beryllium	4	0.46-1.2	—
Cadmium	1	0.63	1
Cobalt	1	7.6	—
Nickel	4	12.7-18.6	20.9
Vanadium	4	27.5-71	—
Zinc	4	51.6-136	68
Selenium	3	0.15-1.4	—
Mercury	2	0.07-0.27	0.1
Chromium	4	37.9-45.8	33

Note:
— = No reported sediment screening value.

Table 4.3.9
SWMU 14
Organic Compounds Detected in Surface Water (μg/L)

Compound Name	No. of Detections	Range of Concentrations	Chronic Marine Water Quality Criteria
Volatile Organic Compounds ***(1 Sample Collected, 0 Samples Duplicated)***			
No VOCs detected			
Semivolatile Organic Compounds ***(1 Sample Collected, 0 Samples Duplicated)***			
No SVOCs detected			
Pesticide Compounds ***(1 Sample Collected, 0 Samples Duplicated)***			
No pesticides detected			
PCB Compounds ***(1 Sample Collected, 0 Samples Duplicated)***			
No PCBs detected			
Appendix IX Herbicide Compounds ***(1 Sample Collected, 0 Samples Duplicated)***			
2,4,5-TP	1	0.34	—
Organophosphate Pesticide Compounds ***(1 Sample Collected, 0 Samples Duplicated)***			
No organophosphates detected			
Dioxin Compounds ***(1 Sample Collected, 0 Samples Duplicated)***			
Dioxins	1	7.327 pg/L	—

Notes:
— = No reported water quality criteria value.

Table 4.3.10
SWMU 14
Inorganic Elements Detected in Surface Water (μg/L)
(1 Sample Collected, 0 Samples Duplicated)

Element	No. of Detections	Range of Concentrations	Chronic Marine Quality Criteria
Lead	1	53.5	8.5
Arsenic	1	338	36
Barium	1	162	—
Nickel	1	18.4	8.3
Vanadium	1	69.6	—
Selenium	1	1.4	71
Mercury	1	0.17	0.025
Hexavalent Chromium		Not Detected	
Cyanide		Not Detected	

Note:
— = No reported water quality criteria value.

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4.4 SWMU 17

SWMU 17 is the site of an oil spill from a ruptured underground fuel pipe beneath Building FBM 61. The 1987 rupture released approximately 14,000 gallons of fuel oil beneath the northcentral extension of Building FBM 61. Soil sampling after the spill identified PCBs in the soil. The building was used for submarine training. Submarine trainers often have PCB oil in their cooling and hydraulic systems. A large bank of transformers is on the north side of the building.

Soil and groundwater were sampled at SWMU 17 to determine whether there was residual contamination from previous oil spills and other spills which may have occurred near SWMU 17.

4.4.1 Soil Sampling and Analysis

Soil was sampled in three phases at SWMU 17 at locations shown on Figure 4.4.1 in accordance with procedures outlined in Section 2.2 of this report. Organic and inorganic analytical data for soil are presented in Tables 4.4.1 and 4.4.2. Appendix I contains a complete analytical report for the samples collected at SWMU 17.

During primary soil sampling, 20 soil samples were collected from 11 locations. Eleven were from the 0- to 1-foot depth interval and nine were from the 3- to 5-foot depth interval. Sample locations were selected on each side of the building extension and on the southern side of Building FBM 61. Locations were selected to detect any impact to soil or groundwater which may have occurred at SWMU 17. Samples were analyzed for VOCs, SVOCs, cyanide, metals, TPH, and pesticides/PCBs. Four samples were selected for duplicate analysis of herbicides, organophosphate pesticides, hexavalent chromium, and dioxins, in addition to the standard suite of analyses.

During the second sampling event, 29 samples were collected from 15 additional locations. Fifteen from the 0- to 1-foot depth interval and 14 from the 3- to 5-foot interval were analyzed for SVOCs, PCBs, metals, and TPH.

During the third round of soil sampling, 16 samples were collected from the upper and lower intervals of eight additional locations. These samples were analyzed for dioxins and PCBs.

4.4.1.1 Volatile Organic Compounds in Soil

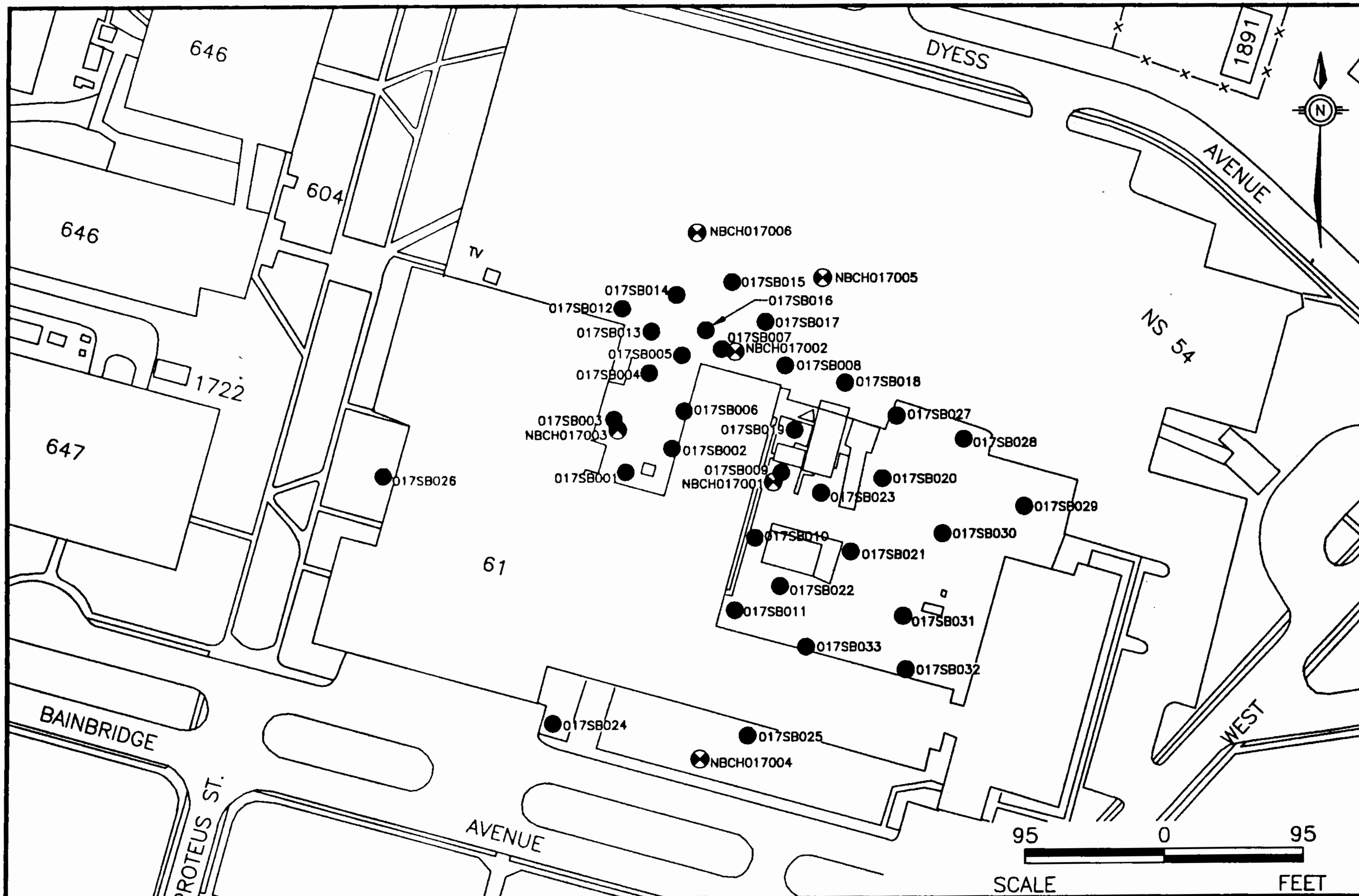
VOCs were detected in 10 of the 11 primary sampling locations, and in 16 of the 20 samples analyzed. Of the 16 samples in which VOCs were detected, six were from the 0- to 1-foot depth and 10 were from the 3- to 5-foot depth. Five VOCs were detected in the soil samples collected at SWMU 17. The concentrations of the VOCs detected ranged from three to five orders of magnitude below their respective RBSLs.

4.4.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected in 9 of the 11 primary sampling locations, 8 of the 15 secondary sampling locations, and in 20 of the 49 samples analyzed from SWMU 17. Of the 20 samples in which SVOCs were detected, 13 were from the 0- to 1-foot depth interval and seven were from the 3- to 5-foot depth interval. Only one SVOC exceeded its RBSL: benzo(a)pyrene at 116 and 175 μg/kg (RBSL-88 μg/kg) in the two surface interval samples at 017SB009 and 017CB022.

4.4.1.3 Pesticides and PCBs in Soil

Pesticides were detected in soil samples from eight of the 11 sample locations and in nine of the 20 samples analyzed. Of the nine samples in which pesticides were detected, four were from the 0- to 1-foot depth interval and five were from the 3- to 5-foot depth interval. The five pesticides detected in soil samples from SWMU 17 were found at concentrations ranging from one to three orders of magnitude below their RBSLs.



LEGEND

● – SOIL SAMPLE LOCATION

⊗ – GROUNDWATER SAMPLE LOCATION

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.4.1
SWMU 17
SOIL & GROUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH41

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PCBs were detected in eight of the 11 primary sampling locations, 11 of the 13 secondary sampling locations, six of the eight tertiary sampling locations, and in of 35 of the 60 samples analyzed. Of the 35 samples in which PCBs were detected, 25 were from the 0- to 1-foot depth interval and 10 were from the 3- to 5-foot depth interval. Aroclors-1254 and 1260 were the only PCBs detected in the soil samples from SWMU 17. Aroclor-1254 did not exceed its RBSL of 83 μg/kg in the one sample where it was detected at 42 μg/kg. Detections of Aroclor-1260 (RBSL-83 μg/kg) ranged from 36 to 245,000 μg/kg. The highest concentrations (approximately four orders of magnitude greater than RBSLs) of Aroclor-1260 were northwest and east of the Building 61 northcentral wing.

4.4.1.4 Other Organic Compounds in Soil

Analysis indicated the presence of petroleum hydrocarbons in 25 of the 49 samples analyzed. Of the 25 samples where petroleum products were was detected, 13 were from the 0- to 1-foot interval and 12 were from the 3- to 5-foot interval. Petroleum hydrocarbons were detected in the 0- to 1-foot depth interval at concentrations ranging from 12,000 to 1,200,000 μg/kg. Petroleum hydrocarbons in the 3- to 5-foot interval ranged from 22,600 to 820,000 μg/kg. At locations where the analyses targeted specific ranges of petroleum hydrocarbons, indeterminate lubricating oil was the most common type of petroleum hydrocarbon detected.

Herbicide 2,4,5-T was detected in two duplicate analyses at concentrations four orders of magnitude below its RBSL.

No organophosphate pesticides were detected in the four duplicate analyses.

TEQs for dioxin (screening level 1000 pg/g) ranged from 0.869 pg/g to 127.03 pg/g for samples collected at SWMU 17. Duplicate analysis of samples collected during the first two rounds of sampling provided data indicating dioxin compounds in the SWMU 17 vicinity. All third-round soil samples were analyzed for dioxins.

4.4.1.5 Inorganic Elements in Soil

Table 4.4.2 summarizes the inorganic results from the soil samples collected at SWMU 17. The only element with detected concentrations greater than its RBSL and interval-specific UTL was cadmium, which was detected at 4.7 mg/kg (RBSL 3.9, upper-interval UTL 1.05)

Cyanide was detected at three of the 11 locations sampled, and in three of all the 20 samples analyzed. All cyanide detections were at least one order of magnitude below its RBSL of 160 mg/kg.

No hexavalent chromium was detected in the four duplicate sample analyses.

4.4.2 Groundwater Sampling and Analysis

Four shallow monitoring wells were installed during the first round to sample groundwater near SWMU 17 (see Figure 4.4.1). Samples from these wells were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. Two additional shallow monitoring wells were installed (NBCH017005 and NBCH017006) based on the analytical results for monitoring well NBCH017002. Samples from these monitoring wells were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. Although the two additional wells were installed shortly after second-round groundwater sampling had begun, data from analyses of their initial samples have been included with the first-round sample results. Consequently, no second-round samples were collected from these two wells. Second-round samples from the four original wells at SWMU 17 were analyzed for VOCs, SVOCs, and metals. A first-round groundwater sample from one of the two additional monitoring wells (NBCH017005) was duplicated and submitted for analysis of dioxin, hexavalent chromium, organophosphate pesticides, and herbicides, in addition to the standard suite of parameters. A second-round sample from one of the four original wells was duplicated and analyzed for the same parameters as the primary second-round samples. Tables 4.4.3 and 4.4.4 present analytical results for organics and inorganics, respectively, in groundwater. Appendix I contains a complete report of the analytical data for groundwater samples collected from SWMU 17.

4.4.2.1 Volatile Organic Compounds in Groundwater

Two VOCs were reported for first-round groundwater samples collected at SWMU 17: acetone at 17.9 μg/L and chlorobenzene at 2.8 μg/L. Both detections came from NBCH017005, one of the two wells installed based on the results of the groundwater samples collected from the first four wells, and both were below their respective RBSLs (acetone=370 μg/L; chlorobenzene=3.9μg/L).

In second-round samples from the four original wells at SWMU 17, chlorobenzene was reported from two wells. It equalled or exceeded its RBSL in samples from NBCH017002 (4,750 μg/L) and NBCH017003 (3.9 μg/L).

4.4.2.2 Semivolatile Organic Compounds in Groundwater

Eight SVOCs were detected in the first-round groundwater samples collected at SWMU 17. The following were detected in the groundwater sample collected from NBCH017002 at concentrations exceeding the corresponding RBSLs for tap water: 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene. Additionally, benzidine was detected in NBCH017005 at a concentration significantly exceeding the RBSL of 0.00029 μg/L. The other three SVOCs detected in the groundwater samples from SWMU 17 did not exceed their respective RBSLs.

In the second sampling round, the same four chlorinated benzene compounds were detected at concentrations exceeding their corresponding RBSLs in the sample from well NBCH017002. 2,4,5-trichlorophenol was reported in the same sample at a concentration of 19 μg/L, well below its RBSL of 370 μg/L. Benzidine was not detected (there was no second-round sample from

NBCH017005), nor were the three SVOCs that were reported at low concentrations in the first round.

4.4.2.3 Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in the first-round groundwater samples collected from wells at SWMU 17.

4.4.2.4 Other Organic Compounds in Groundwater

No petroleum hydrocarbons were detected in the four first-round groundwater samples that were analyzed for TPH. No herbicides, dioxins, or organophosphate pesticides were detected in the first-round groundwater sample submitted for duplicate analysis.

4.4.2.5 Inorganic Elements in Groundwater

The only element exceeding its corresponding RBSL in first-round groundwater samples collected at SWMU 17 was manganese. All six manganese detections exceeded its RBSL of 18 μg/L, but were well below its UTL. No cyanide or hexavalent chromium was detected in the groundwater samples.

In second-round samples at SWMU 17, manganese, arsenic, and chromium were reported at concentrations exceeding their corresponding RBSLs. All four manganese detections were above the RBSL of 18 μg/L, ranging upward to 896 μg/L in well NBCH017004. Arsenic was detected in samples from two wells, both exceeding its RBSL of 0.037 μg/L: NBCH017002 (3.2 μg/L) and NBCH017004 (4.9 μg/L). Chromium (RBSL-18 μg/L) was detected at 40 μg/L in one sample from well NBCH017001. (*Note:* The chromium RBSL of 18 μg/L is based on hexavalent chromium, which has not been detected in any sample in Zone H. The RBSL for trivalent chromium in tap water is 3700 μg/L.) All manganese and arsenic detections were below their corresponding UTLs. Chromium was not detected enough in background samples to determine a valid UTL.

4.4.3 Deviations from Final Zone H RFI Work Plan

Twenty-four soil samples were proposed for collection in the Final Zone H RFI Work Plan. The actual number of soil samples collected at SWMU 17 was 65 (34 upper interval, 31 lower interval). All proposed upper interval samples were collected. Due to shallow depth to groundwater, only some of the second-interval samples were collected. Based on analytical data for soil samples collected during the initial phase of sampling, additional sample locations were identified. Sampling was attempted at both intervals at each of these additional locations. As with the initial phase of sampling, some of the second-interval samples were not collected due to shallow depth to groundwater.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan and two additional locations that were selected based on results of analysis of samples from the first four wells.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.4.1
SWMU 17
Organic Compounds in Soil (µg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(23 Samples Collected — 14 Upper Interval Samples, 9 Lower Interval Samples, 4 Samples Duplicated)***			
Acetone	6/9	13-195/12-176	780,000
Chlorobenzene	0/3	0/3.59-827	160,000
2-Butanone (MEK)	0/3	0/14.4-39.4	4,700,000
Toluene	3/0	4.4-9.6/0	1,600,000
Trichloroethene	1/0	1.8/0	47,000
Semivolatile Organic Compounds ***(49 Samples Collected — 26 Upper Interval Samples, 23 Lower Interval Samples, 4 Samples Duplicated)***			
Acenaphthene	0/1	0/210	470,000
Benzoic Acid	2/1	146-215/99.1	31,000,000
Benzo(a)anthracene	4/0	53.7-186/0	880
Benzo(b)fluoranthene	4/0	51.6-168/0	880
Benzo(k)fluoranthene	1/0	160/0	8,800
Benzo(g,h,i)perylene	1/0	66.7/0	310,000
Benzo(a)pyrene	2/0	116-175/0	88
bis(2-Ethylhexyl)phthalate (BEHP)	11/2	150-830/546-11,130	46,000
Chrysene	4/1	64.6-221/133	88,000
Dibenzofuran	0/1	0/110	31,000
1,2-Dichlorobenzene	0/1	0/219	700,000
1,3-Dichlorobenzene	1/3	43.6/167-6,680	700,000
1,4-Dichlorobenzene	0/3	0/315-5,840	27,000
2,4-Dichlorophenol	0/1	0/63.7	23,000
Di-n-butylphthalate	2/1	64.2-71.4/131	78,000
Fluoranthene	4/2	57.8-346/192-470	310,000
Fluorene	0/1	0/140	310,000
Hexachlorobenzene	0/1	0/285	400

Table 4.4.1
SWMU 17
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Semivolatile Organic Compounds *(49 Samples Collected — 26 Upper Interval Samples, 23 Lower Interval Samples, 4 Samples Duplicated)*			
Indeno(1,2,3-cd)pyrene	1/0	80.8/0	880
Di-n-octylphthalate	0/1	0/317	160,000
Naphthalene	0/1	0/140	310,000
Phenanthrene	2/1	63.1-188/510	310,000
1,2,4-Trichlorobenzene	0/3	0/323-49,600	78,000
Pesticides *(20 Samples Collected — 11 Upper Interval Samples, 9 Lower Interval Samples, 4 Samples Duplicated)*			
alpha-Chlordane	2/0	3.4-5.1/0	470 (alpha + gamma)
gamma-Chlordane	3/0	2.8-12.3/0	
4,4'-DDD	1/3	2.9/14.9/75	2,700
4,4'-DDE	4/6	4.6-581/7.77-652	1,900
Endrin	1/0	2.7/0	2,300
Polychlorinated Biphenyls *(61 Samples Collected — 32 Upper Interval Samples, 29 Lower Interval Samples, 4 Samples Duplicated)*			
Aroclor-1254	1/0	42/0	83
Aroclor-1260	26/10	36-180,000/40-245,000	83
Petroleum Hydrocarbons *(49 Samples Collected — 26 Upper Interval Samples, 23 Lower Interval Samples, 4 Samples Duplicated)*			
Total Petroleum Hydrocarbons (Primarily Indeterminate Lubricating Oil)	12/11	100,000-1,200,000/ 120,000-820,000	Not Listed
Herbicides[a] *(4 Duplicate Analyses — 3 Upper Interval Samples, 1 Lower Interval Sample)*			
2,4,5-T	1/1	7.5/9.9	78,000
Organophosphate Pesticides[a] *(4 Duplicate Analyses — 3 Upper Interval Samples, 1 Lower Interval Sample)*			
No organophosphates detected.			
Dioxins *(20 Samples Collected — 11 Upper Interval Samples, 9 Lower Interval Samples, 4 Duplicate Sample Analyses)*			
Total TEQs	11/9	0.869-127.031/1.258-53.920 pg/g	1000 pg/g

Note:
[a] = Analyses performed only on duplicate samples.

Table 4.4.2
SWMU 17
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	23/20	23/20	938-14,500/5,010-30,100	7,900	25,310/46,180
Iron[a]	23/20	23/20	2,280-17,800/3,050-37,400	Not Listed	30,910/66,170
Lead	23/20	20/19	2.2-41/4.6-32.4	400	118/68.69
Nickel	23/20	13/9	1.1-18.55/1.6-10.20	160	33.38/29.9
Potassium[a]	23/20	6/13	200-1,050/294-2,210	Not Listed	Nutrient[e]
Silver	23/20	2/0	10-34.4/0	39	Not Valid[d]
Sodium[a]	23/20	17/17	41.8-341/72-987	Not Listed	Nutrient[e]
Thallium	23/20	0/0	0/0	0.63	0.63
Antimony	23/20	2/0	2.2-10.1/0	3.1	Not Valid[d]
Arsenic	23/20	20/19	0.90-7.9/2.4-25.6	0.37	14.81/35.52
Barium	23/20	12/9	7.4-23.5/9.3-25.7	550	40.33/43.80
Beryllium	23/20	12/10	0.09-0.64/0.18-1.4	0.15	1.466/1.62
Cadmium	23/20	8/4	0.15-4.7/0.22-0.29	3.9	1.05/1.1
Cobalt	23/20	11/9	0.69-9.8/0.63-5.7	470	5.863/14.88
Copper	23/20	6/3	3.0-74.1/3.5-19.5	290	27.6/31.62
Vanadium	23/20	23/20	4.6-61.8/7.7-66.4	55	77.38/131.62
Zinc	23/20	15/13	3.5-267/6.7-116	2,300	214.3/131.6
Selenium	23/20	0/3	0/0.37-1.9	39	2.0/2.7
Mercury	23/20	14/15	0.02-0.66/0.02-0.3	2.3	0.485/.74
Magnesium[a]	23/20	23/20	214-3790/312-4170	Not Listed	9,592/9,179
Manganese[a]	23/20	21/19	10.7-203/15.3-668	39	636.4/1,412
Calcium	23/20	23/20	1320-347,000/444-984,000	Not Listed	Nutrient[e]
Chromium	23/20	23/19	5.9-34.6/7.4-47.3	39	85.65/83.86
Tin[a]	3/1	0/0	0/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	3/1	0/0	0/0	39	Not Valid[d]
Cyanide	13/9	2/1	1.0-3.0/7.4	160	Not Valid[d]

Notes:
[a] = SW-846 element list and Appendix IX element list do not have these compounds in common.
[b] = Included in duplicate sample analyses only.
[c] = See Appendix J for UTL determination.
[d] = Number of nondetections prevented determination of UTL.
[e] = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.4.3
SWMU 17
Organic Compounds in Groundwater (μg/L)

Round 1: 6 Samples Collected, 1 Sample Duplicated
Round 2: 4 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds					
Acetone	1 2	1 0	17.9 —	370	Not Listed
Chlorobenzene	1 2	1 2	2.8 3.9-4,750	3.9	100
Semivolatile Organic Compounds					
1,2-Dichlorobenzene	1 2	1 1	110 54.5	27	600
1,3-Dichlorobenzene	1 2	1 1	750 550	54	600
1,4-Dichlorobenzene	1 2	1 1	1,100 830	0.44	75
1,2,4-Trichlorobenzene	1 2	1 1	1,000 520	19	70
2,4,5-Trichlorophenol	1 2	0 1	— 19	370	Not Listed
Naphthalene	1 2	1 0	6.1 —	150	Not Listed
Di-n-butylphthalate	1 2	2 0	2.8-3.2 —	370	Not Listed
Benzidine	1 2	1 0	56 —	0.00029	Not Listed
2-Methylnaphthalene	1 2	1 0	4.0 —	150[a]	Not Listed
Pesticides (Round 1: 6 Samples Collected)					
No pesticides detected.					

Table 4.4.3
SWMU 17
Organic Compounds in Groundwater (μg/L)

Round 1: 6 Samples Collected, 1 Sample Duplicated
Round 2: 4 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Polychlorinated Biphenyls (Round 1: 6 Samples Collected)					
No PCBs detected.					
Petroleum Hydrocarbons (Round 1: 4 Samples Collected)					
No petroleum hydrocarbons detected.					
Herbicides (Round 1: 1 Sample Duplicated)					
No herbicides detected.					
Organophosphate Pesticides (Round 1: 1 Sample Duplicated)					
No organophosphate pesticides detected.					
Dioxin (Round 1: 1 Sample Duplicated)					
No dioxin detected.					

Note:
[a] = Naphthalene used as surrogate.

Table 4.4.4
SWMU 17
Inorganic Chemicals in Groundwater (μg/L)

Round 1: 6 Samples Collected, 1 Sample Duplicated
Round 2: 4 Samples Collected, 1 Sample Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[c]	1 2	3 1	35.8-522 33.7	3,800	Not Valid	Not Listed
Arsenic	1 2	0 2	— 3.2-4.9	0.037	27.99	50
Barium	1 2	3 4	6.4-15.3 2.9-19.1	260	323	2,000
Calcium[d]	1 2	6	81,700-179,000	Not Listed	Nutrient	Not Listed
Chromium[c]	1 2	0 1	— 40	18[e]	Not Valid	100
Cobalt[c]	1 2	0 1	— 2.7	220	Not Valid	Not Listed
Copper[c]	1 2	1 0	3.0 —	140	Not Valid	Not Listed
Iron	1 2	6 4	987-7,320 1,475-3,860	Not Listed	45,760	Not Listed
Magnesium	1 2	6 4	10,100-156,000 13,500-45,700	Not Listed	3,866,000	Not Listed
Manganese	1 2	6 4	73.3-630 86.2-896	18	3,391	Not Listed
Potassium[d]	1 2	6 4	8,490-63,800 9,690-17,200	Not Listed	Nutrient	Not Listed
Selenium	1 2	0 2	— 3.2-3.9	18	3.154	50
Sodium[d]	1 2	6 4	10,900-1,340,000 23,200-292,000	Not Listed	Nutrient	Not Listed

Table 4.4.4
SWMU 17
Inorganic Chemicals in Groundwater (μg/L)

Round 1: 6 Samples Collected, 1 Sample Duplicated
Round 2: 4 Samples Collected, 1 Sample Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Vanadium[c]	1 2	0 1	— 3.4	26	Not Valid	Not Listed
Zinc[c]	1 2	0 1	— 25	1100	Not Valid	Not Listed
Cyanide	1 2	Not Detected No Analysis				
Hexavalent Chromium	1 2	Not Detected (1 Sample Duplicated) No Analysis				

Notes:
(a) = Only compounds with detections are listed. Cyanide and hexavalent chromium were separate analyses.
(b) = See Appendix J for UTL determinations.
(c) = High percentage of nondetects in background samples prevented determination of UTL.
(d) = Element considered to be a nutrient; therefore, UTL was not determined.
(e) = If trivalent chromium, RBSL-3,700 μg/L.

4.5 SWMU 19

SWMU 19 is the solid waste transfer station that temporarily stores solid waste before transport offsite. Wastes stored on the bare ground include dry trash, tires, and empty 55-gallon drums.

Soil was sampled at SWMU 19 to evaluate whether the site is contaminated from previous solid waste management activities there. Potential groundwater contamination associated with SWMU 9 is addressed as SWMU 9.

4.5.1 Soil Sampling and Analysis

Six soil samples collected during the primary round of soil sampling at SWMU 19 in accordance with Section 2.2 were analyzed for VOCs, SVOCs, pesticides/PCBs, cyanide, and metals. One was duplicated and analysis included herbicides, hexavalent chromium, organophosphate pesticides, and dioxins. The primary sample locations were position based on the location of the perimeter fence of SWMU 19. Secondary soil samples were collected based on results of first round soil sample analysis. Ten soil samples collected during the second round were analyzed for SVOCs, PCBs, and metals. One sample was duplicated and analysis included herbicides, hexavalent chromium, organophosphate pesticides, and dioxins. Three additional soil samples were collected based on results of the first two sampling events were analyzed for dioxins, metals, SVOCs, and PCBs. In addition to these three samples, one sample was analyzed for only dioxins. All SWMU 19 soil sampling locations are identified on Figure 4.5.1. Tables 4.5.1 (organic) and 4.5.2 (inorganic) summarize of analytical data for soil samples collected at SWMU 19. Appendix I presents the complete analytical report for SWMU 19 samples.

4.5.1.1 Volatile Organic Compounds in Soil

VOCs were detected in all four sampling locations, and in all six samples analyzed. Of the six in which VOCs were detected, four were from the 0- to 1-foot depth interval and two were from the 3- to 5-foot depth interval. Nine VOCs were detected in the SWMU 19 soil samples. VOC concentrations ranged from two to eight orders of magnitude below their respective RBSLs.

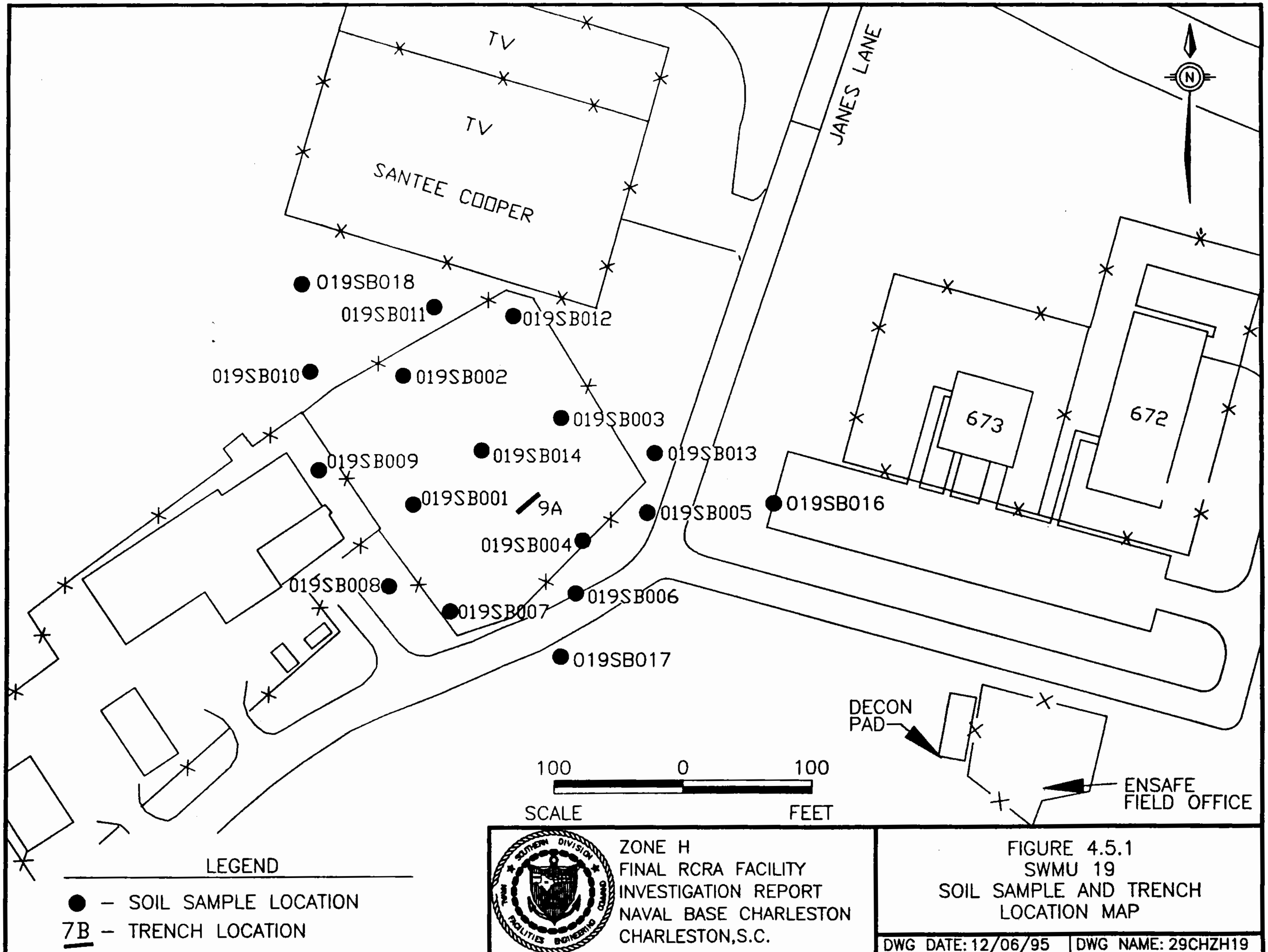
4.5.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected in all four of the primary sampling locations, eight of the 10 secondary sampling locations, and in 13 of all 19 samples analyzed. Of the 13 detections, 12 were from the 0- to 1-foot depth interval and one was from the 3- to 5-foot depth interval. Twenty-four SVOCs were detected in the SWMU 19 soil samples. Four of these were reported at concentrations exceeding the RBSLs: benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and dibenzo(a,h)anthracene. The highest concentrations were near sample location 019SB004 and 019SB002.

4.5.1.3 Pesticides and PCBs in Soil

Pesticides were detected in three of the four sampling locations, and in five of the six samples analyzed. Of the five pesticide detections, three were from the 0- to 1-foot depth interval and two were from the 3- to 5-foot depth interval. Seven pesticide compounds were detected in the SWMU 19 soil samples. Pesticide concentrations ranged from one to four orders of magnitude below respective RBSLs.

PCBs were detected in one of the four primary sampling locations, eight of the 10 secondary sampling locations, and in nine of all 19 samples analyzed. All nine PCB detections were from the 0- to 1-foot depth interval. Two PCB compounds (Aroclors-1254 and 1260) were detected in the soil samples collected from SWMU 19 at concentrations exceeding respective RBSLs. The highest concentrations of Aroclor-1260 were near 019SB004 and 019SB007 sample locations.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.5.1
SWMU 19
SOIL SAMPLE AND TRENCH
LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH19

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4.5.1.4 Other Organic Compounds in Soil

Petroleum hydrocarbons were detected in the two duplicate samples 019CB00201 and 019CB01401 at concentrations of 170,000 and 189,000 μg/kg, respectively.

Herbicide 2,4-D was detected in a duplicate sample at a concentration of 41.8 μg/kg, which is three orders of magnitude below its RBSL of 78,000 μg/kg.

Organophosphate pesticides were not detected in either duplicate sample.

One first-round, two second-round, and three third-round samples were analyzed for dioxins. TEQs for dioxin ranged from 0.507 pg/g to 44.673 pg/g (screening level 1,000 pg/g) for samples collected at SWMU 19. All six samples analyzed for dioxin were collected from the 0- to 1-foot depth interval.

4.5.1.5 Inorganic Elements in Soil

Elements detected in samples collected at SWMU 19 which exceed both their respective RBSLs and UTLs for background are lead, nickel, beryllium, copper, and zinc. Lead, nickel, zinc, and beryllium were present at concentrations which exceeded only the upper-interval UTL. Copper was present in both intervals at concentrations exceeding the interval-specific UTLs. Antimony was present in an upper interval sample at a concentration two orders of magnitude greater than its RBSL. No UTL was prepared for either interval for antimony due to lack of detections. These elements exceeded their respective RBSLs and UTLs by one order of magnitude or less and were relatively evenly distributed across the SWMU 19 sampling area with the most detections at the 019SB004 sampling location.

Cyanide was not detected in any of the nine samples.

No hexavalent chromium was detected in the two duplicate sample analyses.

4.5.2 Deviations from Final Zone H RFI Work Plan

Eight soil samples were proposed for collecting in the Final Zone H RFI Work Plan. The actual number of soil samples collected at SWMU 19 was 20 (18 upper interval, 2 lower interval). All upper interval samples were collected at each proposed location. Due to shallow depth to groundwater, only some of the second-interval samples were collected from the proposed locations. Based on analytical data for soil samples collected during the initial phase of sampling, additional sample locations were identified. Sampling was attempted in both intervals at each of these additional sample locations. As with the initial phase of sampling, some of the second-interval samples at the additional locations were not collected due to shallow depth to groundwater.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.5.1
SWMU 19
Organic Compounds in Soil (in μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(6 Samples Collected — 4 Upper Interval Samples, 2 Lower Interval Samples, 2 Samples Duplicated)***			
Acetone	4/2	20-33/42-47	780,000
Benzene	1/0	64/0	22,000
Carbon disulfide	1/0	9.9/0	780,000
Chlorobenzene	1/0	64/0	160,000
Chloroform	1/0	1.5/0	78,000
1,1-Dichloroethene	2/0	3.5-63/0	1,100
Toluene	5/1	5-72/7	1,600,000
Trichloroethene	2/0	1.3-54/0	47,000
Xylene (total)	1/0	1.6/0	1,600,000
Semivolatile Organic Compounds ***(19 Samples Collected — 17 Upper Interval Samples, 2 Lower Interval Samples, 2 Samples Duplicated)***			
Acenaphthene	2/1	200-217/360	470,000
Acenaphthylene	0/1	0/130	Not Listed
Anthracene	4/1	64.1-357/670	2,300,000
Benzo(a)anthracene	11/1	97-810.5/1,700	880
Benzo(b)fluoranthene	12/1	100-935/1,700	880
Benzo(k)fluoranthene	9/1	110-712/1,200	8,800
Benzo(g,h,i)perylene	3/1	110-215/600	310,000
Benzo(a)pyrene	10/1	110-604/1,400	88
BEHP	10/1	160-9,700/260	46,000
Butylbenzylphthalate	8/1	110-2,300/150	1,600,000
Chrysene	14/1	92-755/1,600	88,000

Table 4.5.1
SWMU 19
Organic Compounds in Soil (in μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Semivolatile Organic Compounds *(19 Samples Collected — 17 Upper Interval Samples, 2 Lower Interval Samples, 2 Samples Duplicated)*			
4-Methylphenol	2/0	125-200/0	39,000
Dibenzo(a,h)anthracene	0/1	0/250	88
Dibenzofuran	2/1	44.8-124/200	31,000
Di-n-butylphthalate	4/0	110-1,100/0	780,000
Di-n-octylphthalate	1/0	150/0	160,000
Fluoranthene	14/1	98-1,590/2,800	310,000
Fluorene	3/1	40.6-218.5/250	310,000
Indeno(1,2,3-cd)pyrene	3/1	91-240/590	880
2-Methylnaphthalene	4/1	100-240/160	310,000
Naphthalene	3/1	140-480/190	310,000
Phenanthrene	13/1	100-1,195/2,500	310,000
Phenol	1/0	100/0	4,700,000
Pyrene	14/1	110-1,430/3,200	230,000
Pesticides *(6 Samples Collected — 4 Upper Interval Samples, 2 Lower Interval Samples, 2 Samples Duplicated)*			
alpha-Chlordane	3/0	2-9.35/0	470 (alpha + gamma)
gamma-Chlordane	3/0	2.7-4/0	
4,4'-DDD	2/2	2-6/5-10	2,700
4,4'-DDE	2/2	4-5/5-12	1,900
4,4'-DDT	1/0	16/0	1,900
Endosulfan II	1/0	2.1/0	47,000
Endrin aldehyde	3/0	14-52/0	23,000

Table 4.5.1
SWMU 19
Organic Compounds in Soil (in μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Polychlorinated Biphenyls *(19 Samples Collected — 17 Upper Interval Samples, 2 Lower Interval Samples, 2 Samples Duplicated)*			
Aroclor-1254	1/0	2,300/0	83
Aroclor-1260	11/0	32-560/0	83
Petroleum Hydrocarbons *2 Samples Collected — 2 Upper Interval, 0 Lower Interval*			
Petroleum Hydrocarbons	2/0	110,000-170,000/0	Not Listed
Herbicides *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
2,4-D	1/0	41.8	78,000
Organophosphate Pesticides *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
No organophosphates detected.			
Dioxin *(6 Samples Collected — 6 Upper Interval, 0 Lower Interval Samples)*			
Total TEQ Values	6/0	0.507-44.673/0 pg/g	1,000 pg/g

Table 4.5.2
SWMU 19
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c] (upper interval/ lower interval)
Aluminum[a]	18/2	17/2	488-1,190/4,240-8,210	7,900	25,310/46180
Iron[a]	18/2	17/2	1,470-26,300/6,900-13,000	Not Listed	30910/66,170
Lead	18/2	16/2	3.4-6,170/61.1-238	400	118/68.69
Nickel	18/2	15/2	2.7-282/8.3-22.5	160	33.38/29.9
Potassium[a]	18/2	3/0	608-1,510/0	Not Listed	Nutrient[e]
Silver	18/2	1/0	0.92/0	39	Not Valid[d]
Sodium[a]	18/2	14/2	35.1-479/210-472	Not Listed	Nutrient[e]
Thallium	18/2	1/0	0.32/0	0.63	0.63/1.3
Antimony	18/2	4/1	1.2-726/1.4	3.1	Not Valid[d]
Arsenic	18/2	14/2	3.0-22.1/7.7-8.3	0.37	14.81/35.52
Barium	18/2	12/2	9.3-128/14-64.1	550	40.33/43.80
Beryllium	18/2	15/2	0.15-3.0/0.29-0.61	0.15	1.466/1.62
Cadmium	18/2	11/2	0.36-1.8/0.55-0.64	3.9	1.05/1.10
Cobalt	18/2	15/2	1.3-43.3/2.1-5.5	470	5.863/14.88
Copper	18/2	15/2	5.9-3,040/49.6-309	290	27.6/31.62

Table 4.5.2
SWMU 19
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c] (upper interval/ lower interval)
Vanadium	18/2	16/2	4.3-43.5/17.6-24.4	55	77.38/131.6
Zinc	18/2	15/2	12.3-2,800/137-359	2,300	214.3/129.6
Selenium	18/2	7/0	0.38-1.1/0	39	2.0/2.7
Mercury	18/2	12/2	0.04-2.1/0.12-0.3	2.3	0.485/.74
Magnesium[a]	18/2	14/2	54.8-4,370/1,050-1,690	Not Listed	9,592/9,179
Manganese[a]	18/2	13/2	36.7-320/64.2-109	1092	636.4/1,412
Calcium	18/2	17/2	933-135,000/9,670-14,000	Not Listed	Nutrient[e]
Chromium	18/2	16/2	4.3-49.2/13.3-20.7	39	85.65/83.86
Tin[a]	2/0	2/0	5.9-43.8/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	2/0	0/0	0/0	39	Not Valid[d]
Cyanide	6/2	0/0	0/0	160	Not Valid[d]

Notes:

(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTL.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

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4.6 SWMU 20

SWMU 20 is an area previously used for waste disposal/storage. Beginning in 1985, various waste materials — batteries, concrete, wood, and sand blasting residue — were stored on the ground at SWMU 20. No containment was provided around the waste storage area.

Based on results of groundwater analysis from temporary and permanent monitoring wells in SWMU 20, soil samples were collected to identify the source of VOC and SVOC contaminants detected in the groundwater. These samples were analyzed for only SVOCs and VOCs in accordance with procedures detailed in Section 2.2. Table 4.6.1 summarizes the analytical data for soil samples. Figure 4.6.1 identifies the soil sampling locations for SWMU 20. Appendix K contains all analytical data for SWMU 20.

Groundwater data for wells installed in SWMU 20 are discussed as SWMU 9.

4.6.1 Soil Sampling and Analysis

Soil was sampled in one phase at SWMU 20. Twelve soil samples were collected from 11 locations. Eleven soil samples were collected from the 0 to 1-foot depth interval and one from the 3- to 5-foot interval. Sample locations were distributed over the former waste storage area to identify the source of groundwater contamination. Soil samples were collected using hand augers as described in Section 2.2.2. Samples were analyzed for VOCs and SVOCs. Two samples selected for duplicate analysis as a QA measure were also analyzed for dioxins. Sample locations are shown on Figure 4.6.1.

4.6.1.1 Volatile Organic Compounds in Soil

Toluene (RBSL-1,600,000 μg/kg), the only VOC detected in the soil samples from SWMU 20, was in 11 of the 12 samples analyzed. The highest concentration was in the 0- to 1-foot interval at sampling location 020SB010 (11 μg/kg), five orders of magnitude below its RBSL.

The results of soil sampling in the area of SWMU 20 did not identify the same VOCs that were detected in the groundwater samples collected in the SWMU 20 area.

4.6.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected at all 11 sampling locations and in all 12 samples collected (both upper and lower sampling intervals). Eighteen semivolatile organic compounds were detected in soil samples from SWMU 20. Most were somewhat uniformly distributed across the sampling area. Four SVOCs were detected above RBSLs in soil samples collected at SWMU 20. At sampling location 020SB005, three of the compounds — benzo(a)anthracene (RBSL-88 μg/kg), benzo(b)fluoranthene (RBSL-880 μg/kg), and benzo(a)pyrene (RBSL-88 μg/kg) — were detected above RBSLs at concentrations of 950 μg/kg, 1,400 μg/kg, and 820 μg/kg, respectively. Benzo(a)pyrene also exceeded its RBSL in samples collected from the 0- to 1-foot interval at sampling locations 020SB001 and 020SB003 and locations 020SB006 through 020SB010, and in a sample collected from the 3- to 5-foot interval at sample location 020SB011. Concentrations of benzo(a)pyrene in these samples ranged from 130 μg/kg to 580 μg/kg. At sampling location 020SB008, dibenzo(a,h)anthracene was detected at a concentration exceeding its RBSL.

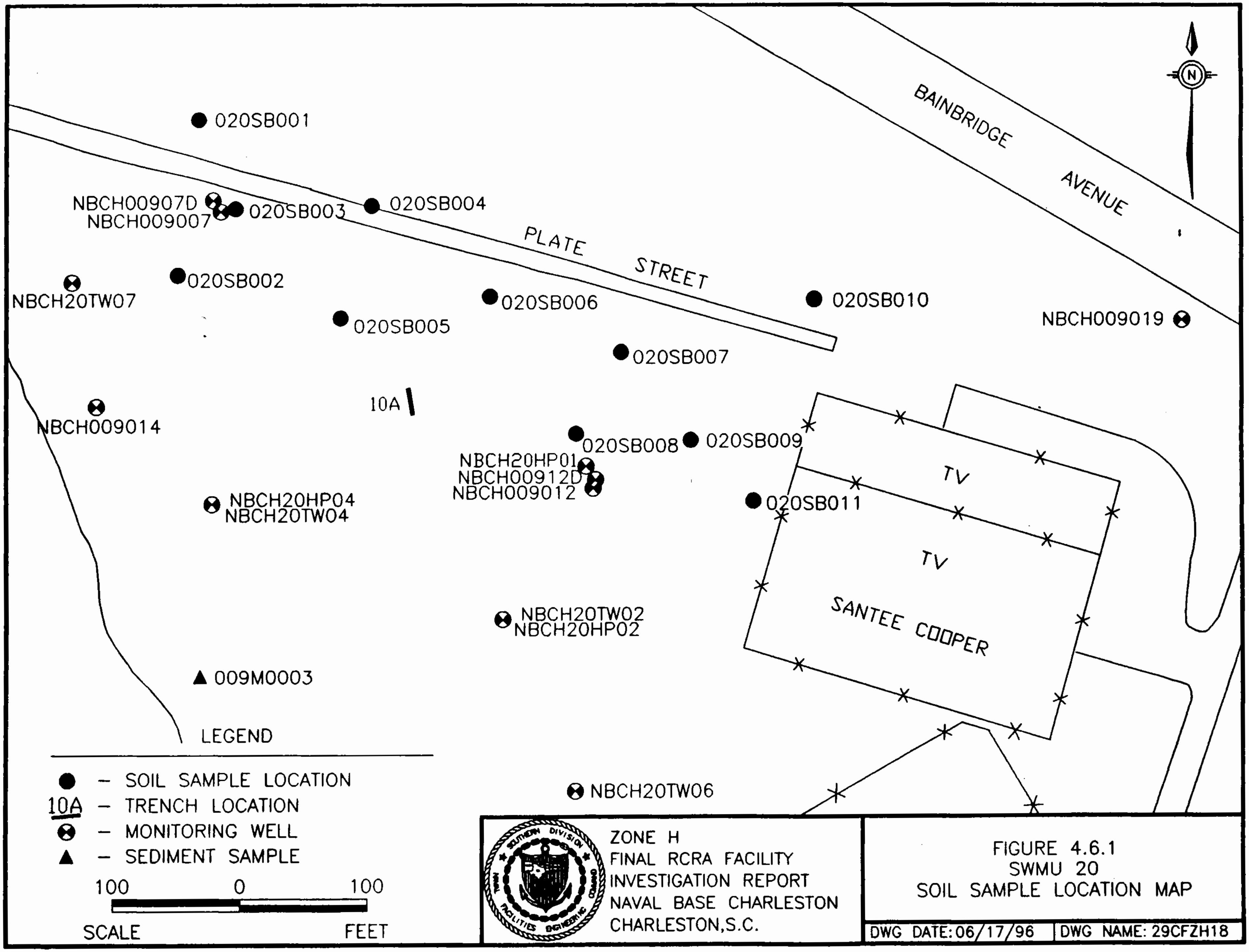
The results of soil sampling in the area of SWMU 20 did not identify the same SVOCs that were detected in the groundwater samples collected in the SWMU 20 area.

4.6.1.3 Pesticides and PCBs in Soil

No samples were analyzed for pesticides and PCBs because these compounds had not been detected in groundwater near SWMU 20.

4.6.1.4 Other Organic Compounds in Soil

No samples were analyzed for TPH, herbicides, or organophosphates because these compounds had not been detected in groundwater near SWMU 20.


BAINBRIDGE AVENUE
PLATE STREET
020SB001
NBCH00907D
NBCH009007
020SB003
020SB004
NBCH20TW07
020SB002
020SB006
020SB010
NBCH009019
020SB005
020SB007
10A
NBCH009014
020SB008
020SB009
NBCH20HP01
NBCH00912D
NBCH009012
TV
020SB011
NBCH20HP04
NBCH20TW04
TV
SANTEE COOPER
NBCH20TW02
NBCH20HP02
009M0003
NBCH20TW06
N
LEGEND
– SOIL SAMPLE LOCATION
10A – TRENCH LOCATION
– MONITORING WELL
– SEDIMENT SAMPLE
100 0 100
SCALE FEET
ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 4.6.1
SWMU 20
SOIL SAMPLE LOCATION MAP
DWG DATE: 06/17/96
DWG NAME: 29CFZH18

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Two soil samples were analyzed for dioxin (screening level 1,000 pg/g). Soil samples collected from the 0- to 1-foot interval at sample locations 020SB001 and 020SB011 contained dioxin total TEQ concentrations of 5.367 pg/g and 1.266 pg/g, respectively.

4.6.1.5 Inorganic Elements in Soil

Two samples were collected in the 1993 data collection event in the SWMU 20 area and analyzed for metals. One of these samples was collected at monitoring well NBCH009007 (see Table 4.1.4 and Figure 4.0). The other sample was collected from the 10A trench (see Table 4.1.2). The monitoring well soil sample (009SB07193) did not contain any elements that were at a concentration which exceeded both the element's respective RBSL and UTL. However, four element's (copper, lead, nickel, and barium) were detected in this sample at concentrations which exceeded the elements UTL (lower than the RBSL). The trench soil sample (009ST10A93) did not contain any concentrations of elements which exceeded both their RBSL and interval-specific UTL. However, three elements (copper, nickel, and zinc) were detected at concentrations which exceeded their UTLs but did not exceed their RBSLs, and two elements (manganese and arsenic) were detected at concentrations which exceeded their respective RBSLs but did not exceed their UTLs.

4.6.2 Deviations from Final Zone H RFI Work Plan

No soil samples were proposed to be collected in the SWMU 20 area in the Final Zone H RFI Work Plan (Table 4.0.3). However, data from temporary and permanent monitoring wells (SWMU 9 groundwater investigation) suggested the presence of a contamination source in the SWMU 20 area. As a result of the groundwater data, 12 (11 upper interval, one lower interval) soil samples were collected at SWMU 20. Due to shallow depth to groundwater, only one of the second-interval samples was collected from the sampling locations. Both sampling intervals were attempted at each of the 11 sample locations.

Table 4.6.1
SWMU 20
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(12 Samples Collected — 11 Upper Interval Samples, 1 Lower Interval Sample, 2 Samples Duplicated)***			
Toluene	10/1	2.8-11/5	1,600,000
Semivolatile Organic Compounds ***(12 Samples Collected — 11 Upper Interval Samples, 1 Lower Interval Sample, 2 Samples Duplicated)***			
Acenaphthene	2/0	100-210/0	470,000
Dibenzofuran	2/0	89-220/0	31,000
Fluorene	2/0	140-340/0	310,000
Phenanthrene	9/1	110-1,900/780	310,000
Anthracene	4/1	74-450/170	2,300,000
Fluoranthene	10/1	140-2,000/1,300	310,000
Pyrene	10/1	200-2,800/1,200	230,000
Butylbenzylphthalate	2/1	91-190/430	1,600,000
Naphthalene	1/0	99/0	310,000
Benzo(a)anthracene	10/1	79-950/580	880
Chrysene	10/1	110-940/610	88,000
bis(2-Ethylhexyl)phthalate	9/1	110-8,165/380	46,000
Benzo(b)fluoranthene	10/1	110-1,400/680	880
Benzo(k)fluoranthene	10/1	110-660/400	8,800
Benzo(a)pyrene	9/1	87-820/430	88
Indeno(1,2,3-cd)pyrene	5/0	78-260/0	880
Dibenzo(a,h)anthracene	2/0	75-100/0	88
Benzo(g,h,i)perylene	5/0	78-250/0	310,000
Dioxins ***(2 Samples Duplicated — 2 Upper Interval Samples, 0 Lower Interval Samples)***			
Total TEQ	2/0	1.266-6.241/0 pg/g	1,000 pg/g

4.7 SWMU 121

SWMU 121 is the site of Building 801 and its associated SAA. For the previous six years, Building 801 has been used to collect, sort, and store recyclable material. The associated SAA was an 8-foot by 8-foot sheet metal building with a concrete floor where hazardous waste was accumulated. The SAA had no secondary containment structures.

Soil was sampled at SWMU 121 to evaluate whether it was contaminated from Building 801 and the SAA. Potential groundwater contamination associated with SWMU 121 is addressed as SWMU 9.

4.7.1 Soil Sampling and Analysis

Soil was sampled in three phases at SWMU 121. During primary soil sampling, one sample was collected from 0 to 1 foot at five locations near Building 801 and the SAA to detect possible contamination from them. The five soil sample locations were based on the shape of the area enclosed by the perimeter fence. Soil was sampled in accordance with the procedures outlined in Section 2.2 of this report and analyzed for the standard suite of compounds: VOCs, SVOCs, cyanide, metals, TPH and pesticides/PCBs. In addition to the standard suite of compounds, one sample was split for duplicate analysis as a QA measure and analyzed for hexavalent chromium, herbicides, organophosphate pesticides, and dioxins. During secondary sampling, seven soil samples were collected from six locations, which were based on results of the primary round of sampling. Two intervals were sampled at one location and only the upper interval was sampled at the remaining six secondary sampling locations. Secondary samples that were collected based on the results of the first round of soil sample analysis were analyzed for SVOCs, PCBs, and metals. The third round of soil samples was collected based on the analytical results of the first and second rounds. In the third round, five additional soil samples collected from the upper interval were analyzed for SVOCs, PCBs, and metals. Sample locations for the three sampling events are shown on Figure 4.7.1. Tables 4.7.1 (organic) and 4.7.2 (inorganic) summarize the analytical data for SWMU 121 soil samples. Appendix I contains a complete report of analytical data for soil samples collected at SWMU 121.

4.7.1.1 Volatile Organic Compounds in Soil

Volatile organic compounds were detected in five samples from the upper sampling interval at primary sample locations. Six VOCs were reported at concentrations ranging from approximately two to six orders of magnitude below the RBSLs.

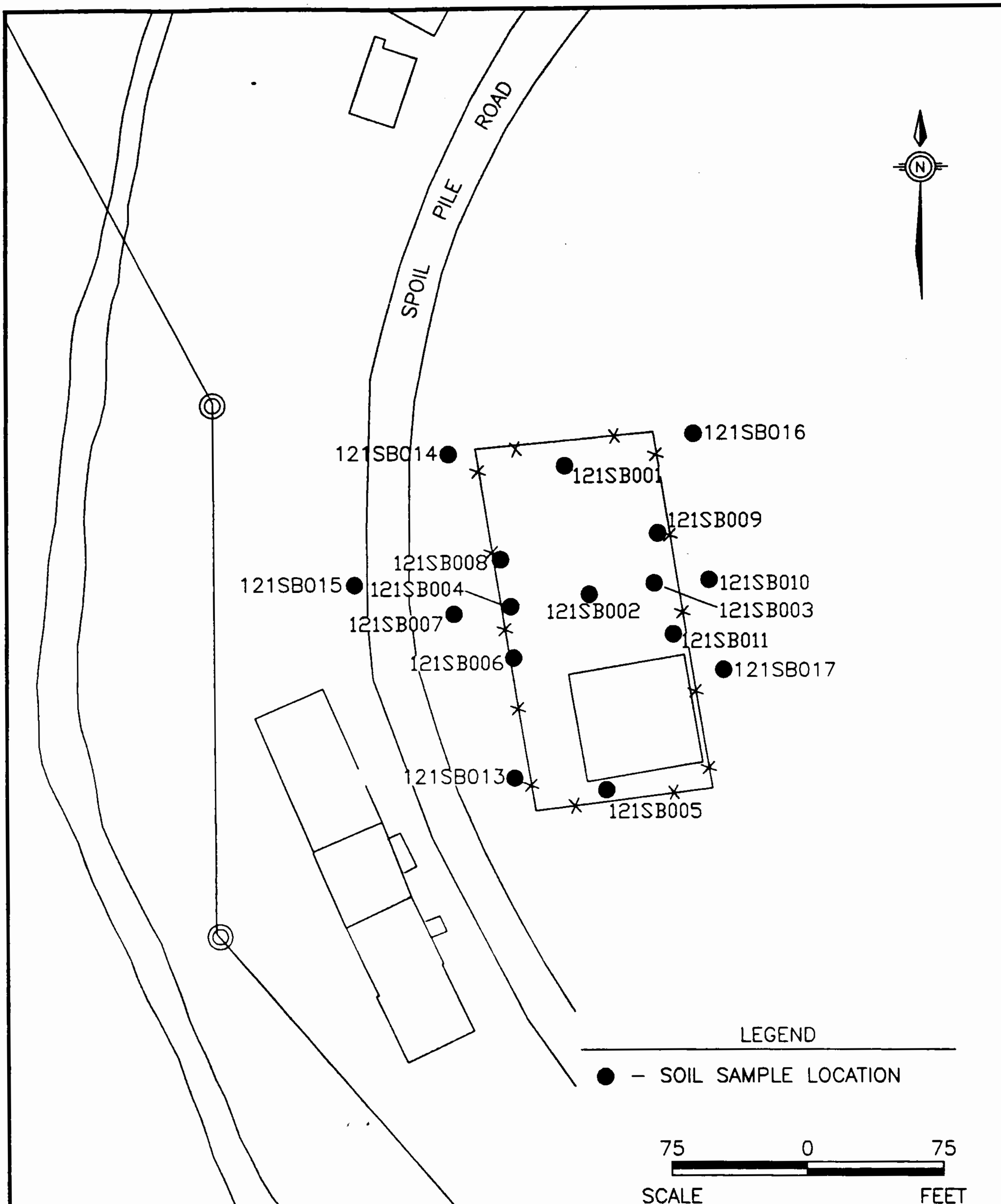
4.7.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected in 13 of the 16 sampling locations and in 14 of the 17 samples. Twenty-one SVOCs were detected in the soil samples collected at SWMU 121. The following exceeded the RBSLs: benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and dibenzo(a,h)anthracene. The highest concentrations were generally on the eastern side of SWMU 121 and at sampling location 121SB013. Samples from 121SB011 and 121SB013 exceeded the RBSLs for all four indicated SVOCs. Samples from 121SB002, 121SB007, 121SB09, 121SB010, 121SB014, 121SB015, and 121SB016 also exceeded the RBSL for at least one indicated SVOC.

4.7.1.3 Pesticides and PCBs in Soil

Pesticide compounds were detected in upper-interval soil samples from four of the five primary sampling locations. Five pesticide compounds were detected in the soil samples collected at SWMU 121 at concentrations ranging from two to three orders of magnitude below the RBSLs.

PCB compounds were detected in three of the five primary sampling locations, five of six secondary sampling locations, four of five tertiary sampling locations, and in 13 of all 17 samples collected. Three different PCB compounds (Aroclors-1248, 1254, and 1260) were detected in SWMU 121 soil samples at concentrations exceeding their RBSLs. The PCB compounds were distributed across the central area of SWMU 121 and past the fence to the east



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.7.1
SWMU 121
SOIL SAMPLE LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH17

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and west. The highest concentrations were at location 121SB0016 with reported concentrations of Aroclor-1254 (4,300 μg/kg) and Aroclor-1260 (1,100 μg/kg).

4.7.1.4 Other Organic Compounds in Soil

TPH analysis indicated the presence of petroleum hydrocarbons in the single sample analyzed — the duplicate sample from the upper interval at location 121SB002. Petroleum hydrocarbons were detected in that sample at a concentration of 150,000 μg/kg.

No herbicides or organophosphate pesticides were detected in the duplicate analysis.

Six samples were analyzed for dioxin. Total TEQs for dioxin ranged from 12.891 pg/g to 194.231 pg/g (screening level 1,000 pg/g) for samples collected at SWMU 121.

4.7.1.5 Inorganic Elements in Soil

Inorganics that exceed both their respective RBSLs and UTLs for background are lead, nickel, thallium, arsenic, beryllium, copper, vanadium, zinc, manganese, mercury, and chromium. Lead, nickel, beryllium, copper, vanadium, and zinc were detected at concentrations exceeding both interval-specific UTLs. Detected concentrations of thallium, arsenic, mercury, manganese, and chromium exceeded only their upper-interval UTLs. Iron was also present at concentrations which exceeded its upper-interval UTL. No RBSL was available for iron. The northern and western sample locations contained the largest quantity of detections for elements with concentrations exceeding their respective RBSLs and UTLs of background, specifically in the vicinity of 121SB004, 121SB006, 121SB007, 121SB002, 121SB009, 121SB016, and 121SB014.

Cyanide was detected in one of the five samples analyzed for cyanide. Analysis for cyanide in the upper sampling interval at location 121SB00001 indicated a concentration of 9.9 mg/kg, one order of magnitude less than its RBSL.

No hexavalent chromium was detected in the one duplicate analysis.

4.7.2 Deviations from Final Zone H RFI Work Plan

Ten soil samples were proposed for collection in the Final Zone H RFI Work Plan. The actual number of soil samples collected at SWMU 121 was 18 (17 upper interval, one lower interval). All upper interval samples were collected at each proposed location. Due to shallow depth to groundwater, some of the second-interval samples were collected from the proposed locations. Based on analytical data for soil samples collected during the initial phase of sampling, additional sample locations were identified. Sampling was attempted at both intervals at each of these additional sample locations. As with the initial phase of sampling, some second-interval samples at the additional sample locations were not collected due to shallow depth to groundwater.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.7.1
SWMU 121
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(5 Samples Collected — 5 Upper Interval Samples, 1 Sample Duplicated)***			
Acetone	4/0	15-193.5/0	780,000
2-Butanone (MEK)	1/0	37.1/0	4,700,000
4-Methyl-2-Pentanone (MIBK)	1/0	2.4/0	390,000
Toluene	3/0	4.3-13/0	1,600,000
Xylene (total)	2/0	2.4-6/0	1,600,000
Acrylonitrile[a]	1/0	34.5/0	1,200
Semivolatile Organic Compounds ***(17 Samples Collected — 16 Upper Interval Samples, 1 Lower Interval Sample, 1 Sample Duplicated)***			
Acenaphthene	1/0	130/0	470,000
Acenaphthylene	2/0	160-590/0	Not Listed
Anthracene	6/0	100-610/0	230,0000
Benzo(a)anthracene	8/1	93-1,900/160	880
Benzo(b)fluoranthene	11/1	92-2,700/200	880
Benzo(k)fluoranthene	8/1	69-2,200/230	8,800
Benzo(g,h,i)perylene	6/1	83.7-780/93	310,000
Benzo(a)pyrene	11/1	77-1,700/200	88
BEHP	9/0	62-1,000/0	46,000
Butylbenzylphthalate	4/0	88-2,600/0	1,600,000
Chrysene	10/1	87-2,000/170	88,000
Dibenzo(a,h)anthracene	5/0	98-280/0	88
Dibenzofuran	1/0	89/0	31,000
Diethylphthalate	1/0	85.2/0	6,300,000
Fluoranthene	11/1	120-3,900/330	310,000
Fluorene	1/0	200/0	310,000
Indeno(1,2,3-cd)pyrene	7/0	50.2-750/0	880
2-Methylnaphthalene	2/0	110-470/0	310,000

Table 4.7.1
SWMU 121
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Semivolatile Organic Compounds *(17 Samples Collected — 16 Upper Interval Samples, 1 Lower Interval Sample, 1 Sample Duplicated)*			
Naphthalene	1/0	330/0	310,000
Phenanthrene	9/1	85-2,200/160	310,000
Pyrene	12/1	93-3,400/310	230,000
Pesticides *(5 Samples Collected — 5 Upper Interval Samples, 1 Sample Duplicated)*			
gamma-Chlordane	1/0	4/0	470 alpha + gamma
4,4'-DDE	3/0	3-20.5/0	1,900
4,4'-DDT	1/0	14/0	1,900
Endosulfan II	2/0	24-25/0	47,000
Endrin aldehyde	1/0	24.3/0	2,300
Polychlorinated Biphenyls *(17 Samples Collected—16 Upper Interval Samples, 1 Lower Interval Sample, 1 Sample Duplicated)*			
Aroclor-1248	4/1	66-160/37	83
Aroclor-1254	7/1	140-4,300/82	83
Aroclor-1260	12/1	110-1,100/88	83
Total Petroleum Hydrocarbons *(1 Duplicated Analysis—1 Upper Interval Sample)*			
Total Petroleum Hydrocarbons	1/0	150,000/0	not listed
Herbicides *(1 Duplicate Analyses—1 Upper Interval Sample)*			
No herbicides detected.			
Organophosphate Pesticides *(1 Duplicate Analyses—1 Upper Interval Sample)*			
No organophosphates detected.			
Dioxins *(6 Samples Collected—6 Upper Interval Samples, 0 Lower Interval Samples)*			
Total TEQ Values	6/0	12.891-194.231/0 pg/g	1,000 pg/g

Notes:
(^{a}) = Compound included in the Appendix IX analysis but not in the SW-846 analysis.

Table 4.7.2
SWMU 121
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	16/1	16/1	719-16,000/15,500	7,900	25,310/46,180
Iron[a]	16/1	16/1	2,230-80,800/27,600	Not Listed	30,910/66,170
Lead	16/1	16/1	40.6-2,770/508	400	118/68.69
Nickel	16/1	16/1	4.6-995/142	160	33.38/29.9
Potassium[a]	16/1	3/1	739-1,130/1,390	Not Listed	Nutrient[e]
Silver	16/1	6/0	0.33-1.2/0	39	Not Valid[d]
Sodium[a]	16/1	16/1	39-1,600/624	Not Listed	Nutrient[e]
Thallium	16/1	1/0	2.7/0	0.63	0.63
Antimony	16/1	4/0	2.8-7.3/0	3.1	Not Valid[d]
Arsenic	16/1	11/1	3.5-18.7/10.7	0.37	14.81/35.52
Barium	16/1	14/1	19-530/89.7	550	40.33/43.80
Beryllium	16/1	16/1	0.16-14.6/2.6	0.15	1.466/1.62
Cadmium	16/1	12/0	0.63-2.5/0	3.9	1.05/1.10
Cobalt	16/1	16/1	1.0-97.2/15.9	470	5.863/14.88
Copper	16/1	15/1	60-4,060/680	290	27.6/31.62
Vanadium	16/1	16/1	6.2-470/64.8	55	77.38/131.6
Zinc	16/1	16/1	79-15,100/1,750	2,300	214.3/129.6
Selenium	16/1	10/0	0.41-3.2/0	39	2.0/2.7
Mercury	16/1	11/1	0.03-3.5/0.7	2.3	0.485/.74
Magnesium[a]	16/1	11/1	284-4,190/2,590	Not Listed	9,592/9,179
Manganese[a]	16/1	11/1	20.70-1,020/251	39	636.4/1,412
Calcium	16/1	16/1	6,530-313,000/15,700	Not Listed	Nutrient[e]
Chromium	16/1	16/1	7.8-210/50.8	39	85.65/83.86
Tin[a]	1/0	1/0	19.7/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	1/0	0/0	0/0	39	Not Valid[d]
Cyanide	5/0	1/0	9.9/0	160	Not Valid[d]

Notes:
(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTL.
(e) = Elements considered to be nutrients; therefore, UTL was not determined

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4.8 SWMU 178

SWMU 178 is the site of a transformer-oil leak from an underground transformer vault approximately 50 feet south of Building X33-A. The leak was identified in 1994. Soil and groundwater were sampled to investigate any residual contamination from the previous oil leak and other possible spills or leaks.

4.8.1 Soil Sampling and Analysis

Twelve soil samples were collected from two depth intervals (0- to 1-foot and 3- to 5-foot) at six locations near SWMU 178. The locations were sampled using hand augers as described in Section 2.2.2. Sampling locations generally conformed to those identified in the Final Zone H RFI Work Plan — one each outside the transformer vault's four corners, one north of the transformer vault near a UST, and one opposite the vault away from the fill pipe to detect possible residual contamination from the oil spill. Figure 4.8.1 identifies each sampling location.

All 12 samples were analyzed for VOCs, SVOCs, pesticides/PCBs, cyanide, metals, and TPH. One was split to serve as a QC duplicate, and additionally analyzed for herbicides, hexavalent chromium, dioxins, and organophosphate pesticides. Analytical results are summarized in Tables 4.8.1 (organic) and 4.8.2 (inorganic). Appendix I contains the full analytical report for SWMU 178.

4.8.1.1 Volatile Organic Compounds in Soil

Six volatile organic compounds (acetone, acrylonitrile, chlorobenzene, 2-butanone, toluene, and xylene) were detected in the soil samples from SWMU 178. All VOCs were in concentrations ranging from two to six orders of magnitude below their RBSLs. Toluene, the most prevalent VOC, was detected in eight samples (six upper-interval and two lower-interval) at concentrations five to six orders of magnitude below RBSL.

4.8.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected in four of the 12 soil samples collected at SWMU 178 (two upper-interval samples and two lower-interval samples). Nine SVOCs were detected. Only two SVOCs, (benzo(a)pyrene (RBSL-88 μg/kg) and di-n-octylphthalate (RBSL-160 μg/kg), were at concentrations above their RBSLs. A soil sample from the 0- to 1-foot interval at sample location 178SB005 contained benzo(a)pyrene at a concentration of 140 μg/kg as well as seven other SVOCs below RBSLs. A soil sample from the 3- to 5-foot interval at sample location 178SB002 contained di-n-octylphthalate at a concentration of 226 μg/kg.

4.8.1.3 Pesticides and PCBs in Soil

Pesticides were detected in samples from five of the six SWMU 178 sampling locations. In four locations, pesticides were in the upper and lower sample interval. At one location, six pesticides were detected in only the upper interval, at concentrations ranging from one to two orders of magnitude below their RBSLs.

Although the site was a transformer vault with a documented leak, no PCBs were detected in the soil samples collected at SWMU 178.

4.8.1.4 Other Organic Compounds in Soil

TPH analysis identified petroleum hydrocarbons at five of six sample locations. At three locations (178SB001, 178SB003, and 178SB005) petroleum hydrocarbons were detected in both the 0- to 1-foot and 3- to 5-foot sampling intervals. At the other two (178SB002 and 178SB004), petroleum hydrocarbons were detected in only the upper sampling interval. TPH concentrations at SWMU 178 ranged from 140,000 to 37,000,000 μg/kg. The higher TPH concentrations occurred at sample locations 178SB001 and 178SB005 in the lower sampling interval.

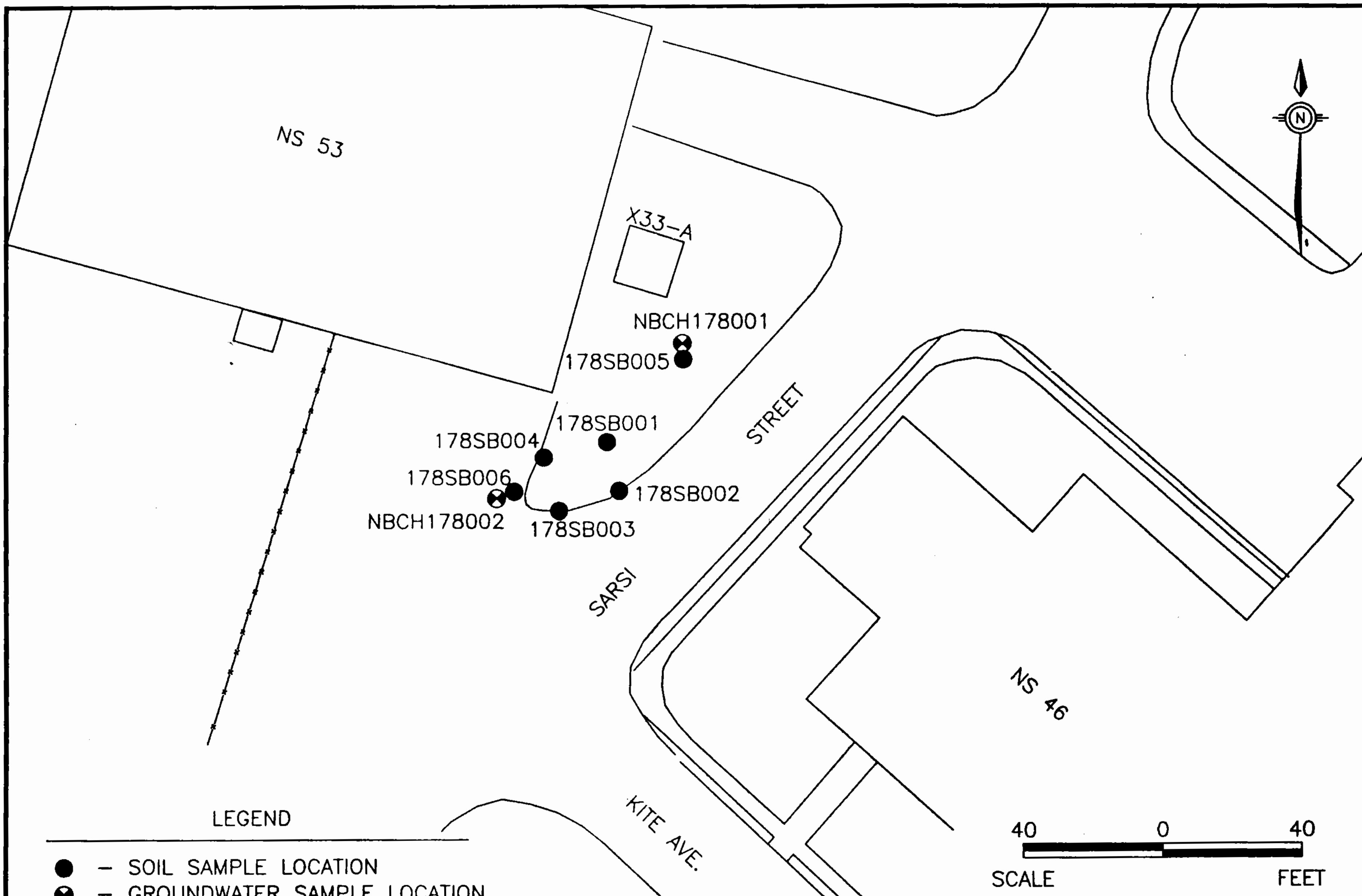

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FIGURE 4.8.1
SWMU 178
SOIL AND GROUNDWATER
SAMPLE LOCATION MAP

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No herbicides or organophosphate pesticides were detected in the soil samples collected at SWMU 178.

Dioxins (screening level 1,000 pg/g) were present in the sample collected for duplicate analysis from SWMU 178. A soil sample from the 0- to 1-foot interval at location 178SB002 contained dioxin at a TEQ concentration of 0.299 pg/g.

4.8.1.5 Inorganic Elements in Soil

Table 4.8.2 summarizes the results for the inorganic chemical element analysis for the soil samples collected at SWMU 178. One element, thallium, was detected at one location at a concentration exceeding its RBSL and lower-interval UTL. A soil sample collected from the 3- to 5-foot interval at location 178SB002 contained thallium at a concentration of 2.2 μg/kg. The RBSL for this element is 0.63 μg/kg, and the lower-interval UTL is 1.3 mg/kg.

No cyanide or hexavalent chromium were detected in the soil samples collected for SWMU 178.

4.8.2 Groundwater Sampling and Analysis

Two shallow monitoring wells were installed near SWMU 178 (Figure 4.8.1) for groundwater sampling, in accordance with Section 2.4 of this report. First-round samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. Based on first-round sample results, second-round samples were analyzed only for SVOCs and metals. Both second-round samples were duplicated and analyzed for the same parameters as the primary samples. Results of the groundwater sample analyses are listed in Table 4.8.3 (organic compounds) and 4.8.4 (inorganic chemicals). All analytical data for groundwater samples collected at SWMU 178 are presented in Appendix I.

4.8.2.1 Volatile Organic Compounds in Groundwater

No VOCs were detected in the groundwater samples collected at SWMU 178.

No SVOCs were detected in first-round groundwater samples from wells at SWMU 178.

BEHP was the only SVOC detected in second-round samples at SWMU 178. It was reported at a concentration of 530 μg/L in the sample from well NBCH178001, greatly exceeding its RBSL of 4.8 μg/L.

4.8.2.3 Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in the groundwater samples collected at SWMU 178.

4.8.2.4 Other Organic Compounds in Groundwater

No petroleum hydrocarbons were detected in the groundwater samples collected at SWMU 178.

4.8.2.5 Inorganic Elements in Groundwater

Only arsenic and manganese were reported at concentrations above their corresponding RBSLs at SWMU 178. Manganese (RBSL-18 μg/L) was detected in a first-round groundwater sample from NBCH178001 at a concentration of 158.0 μg/L, and in a second-round sample from NBCH178002 at a concentration of 19.75 μg/L. Arsenic (RBSL-0.038 μg/L) was found only in the second-round sample from well location NBCH178002, at a concentration of 4.9 μg/L. Reported concentrations of both elements were below their respective UTLs.

No cyanide was detected in the groundwater samples collected at SWMU 178.

4.8.3 Deviations from Final Zone H RFI Work Plan

All soil samples proposed to be collected in the Final Zone H RFI Work Plan were collected.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.8.1
SWMU 178
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(12 Samples Collected — 6 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)***			
Acetone	0/1	0/52	78,000
Chlorobenzene	0/1	0/6	160,000
2-Butanone (MEK)	0/1	0/10	4,700,000
Toluene	6/2	3.7-11/7-8.95	1,600,000
Xylene (total)	0/1	0/5.1	1,600,000
Acrylonitrile[a]	0/1	0/7.8	1,200
Semivolatile Organic Compounds ***(12 Samples Collected — 6 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)***			
Benzo(a)anthracene	1/0	140/0	880
Benzo(b)fluoranthene	2/0	88-200/0	8,800
Benzo(k)fluoranthene	1/0	130/0	8,800
Benzo(a)pyrene	1/0	140/0	88
Chrysene	1/0	150/0	88,000
Di-n-octylphthalate	0/1	0/226	160
Fluoranthene	1/1	270/210	310,000
Phenanthrene	1/0	110/0	310,000
Pyrene	2/1	120-290/270	230,000
Pesticides ***(12 Samples Collected — 6 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)***			
alpha-Chlordane	3/0	2-3/0	470 (alpha + gamma)
gamma-Chlordane	3/0	3-8/0	
4,4'-DDD	1/3	4/43-92	2,700
4,4'-DDE	5/4	12-220/4.1-35	1,900
4,4'-DDT	5/2	9-93/3.9-10	1,900
Heptachlor epoxide	1/0	3/0	70

Table 4.8.1
SWMU 178
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Polychlorinated Biphenyls ***(12 Samples Collected — 6 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)***			
No PCBs detected.			
Total Petroleum Hydrocarbons ***(12 Samples Collected — 6 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)***			
Total Petroleum Hydrocarbons	5/3	140,000-900,000/280,000-37,000,000	Not Listed
Herbicides ***(1 Duplicate Analysis — 1 Lower Interval Sample)***			
No herbicides detected.			
Organophosphate Pesticides ***(1 Duplicate Analysis — 1 Lower Interval Sample)***			
No organophosphates detected.			
Dioxins ***(1 Duplicate Analysis — 1 Lower Interval Sample)***			
Total TEQ	0/1	0/0.299 pg/g	1000 pg/g

Note:
[a] = Compound included in the Appendix IX analysis but not in the SW-846 analysis.

Table 4.8.2
SWMU 178
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	6/6	6/6	4,570-11,000/1,160-6,050	7,900	25,310/46180
Iron[a]	6/6	6/6	4,170-12,300/1,320-8,760	Not Listed	30,910/66170
Lead	6/6	1/1	5.5/5.1	400	118/68.69
Nickel	6/6	0/2	0/1.3-20.8	160	33.38/29.9

Table 4.8.2
SWMU 178
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Potassium[a]	6/6	1/0	502.0/0	Not Listed	Nutrient[e]
Silver	6/6	0/0	0/0	39	Not Valid[d]
Sodium[a]	6/6	5/2	26.1-577/64.3-1,190	Not Listed	Nutrient[e]
Thallium	6/6	0/2	0/0.52-2.2	0.63	0.63/1.3
Antimony	6/6	2/4	1.4-1.4/1.1-8.6	3.1	Not Valid[d]
Arsenic	6/6	3/3	3.6-7.7/1.3-8.7	0.37	14.81/35.52
Barium	6/6	2/1	11.3-40.3/7.8	550	40.33/43.80
Beryllium	6/6	1/2	0.08/0.16-0.31	0.15	1.466/1.62
Cadmium	6/6	0/0	0/0	3.9	1.05/1.10
Cobalt	6/6	1/1	0.68/1.1	470	5.863/14.88
Copper	6/6	5/6	0.94-15.3/0.73-6.8	290	27.6/31.62
Vanadium	6/6	1/2	16.8/13.6-25.4	55	77.38/131.6
Zinc	6/6	1/1	160/37.2	2,300	214.3/129.6
Selenium	6/6	2/1	0.47-0.93/0.7	39	2.0/2.7
Mercury	6/6	0/1	0/0.03	2.3	0.485/.74
Magnesium[a]	6/6	6/6	209-3,860/373-5,970	Not Listed	9,532/9,179
Manganese[a]	6/6	5/3	12.9-66.1/29.5-46.8	39	636.4/1,412
Calcium	6/6	5/5	844-56,600/2,840-260,000	Not Listed	Nutrient[e]
Chromium	6/6	2/2	7.0-14.9/7.6-49.0	39	85.65/83.86
Tin[a]	0/1	0/0	0/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	0/1	0/0	0/0	39	Not Valid[d]
Cyanide	6/6	0/0	0/0	160	Not Valid[d]

Notes:

(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTL.
(e) = Elements considered to be nutrients, therefore, UTL was not determined.

Table 4.8.3
SWMU 178
Organic Compounds in Groundwater ($\mu g/L$)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 2 Samples Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds (Collected in Round 1 Only)					
No VOCs detected.					
Semivolatile Organic Compounds (Collected in Rounds 1 and 2)					
BEPH	1	0	--	4.8	6
	2	1	530		
Pesticides (Collected in Round 1 Only)					
No pesticides detected					
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Collected in Round 1 Only)					
No TPH detected.					

Table 4.8.4
SWMU 178
Inorganic Chemicals in Groundwater (µg/L)[a]

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 2 Samples Duplicated

Chemical Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[c]	1	1	15.5	3700	Not Valid	Not Listed
	2	1	140.35			
Arsenic	1	0	--	0.038	27.99	50
	2	1	4.9			
Barium	1	1	2.8	260	323	2000
	2	1	4.70			
Calcium[d]	1	2	37,100-267,000	Not Listed	Nutrient	Not Listed
	2	2	33,450-68,000			
Chromium[c]	1	0	--	18[e]	Not Valid	100
	2	1	2.7			
Iron	1	2	301-365	Not Listed	45,760	Not Listed
	2	2	352-989			
Magnesium	1	2	31,400-65,700	Not Listed	3,866,000	Not Listed
	2	2	30,750-108,000			
Manganese	1	2	13.1-158	18	3,391	Not Listed
	2	2	12.60-19.75			
Nickel[c]	1	0	--	73	Not Valid	100
	2	1	6.9			
Potassium[d]	1	2	20,700-33,800	Not Listed	Nutrient	Not Listed
	2	2	18,950-64,550			
Sodium[d]	1	2	113,000-259,000	Not Listed	Nutrient	Not Listed
	2	2	110,500-841,500			
Vanadium[c]	1	0	--	26	Not Valid	Not Listed
	2	1	4.5			
Cyanide[c]	1	--	Not Detected			
	2	--	No Analysis			

Notes:

(a) = Only elements with detections are listed. Cyanide was a separate analysis.
(b) = See Appendix J for UTL determinations.
(c) = High percentage of nondetects in background samples prevented determination of UTL.
(d) = Element considered to be a nutrient; therefore, UTL was not determined.
(e) = If trivalent chromium, RBSL-3700 µg/L.

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4.9 AOCs 649, 650, and 651

Because of their proximity, AOCs 649, 650, and 651, which are all east of Building 672, have been grouped. AOC 649, the former Braswell Storage Area, stored sandblast media, welding supplies, and other unknown supplies used in ship repair. Material was stored for an unknown length of time during the 1970s. AOC 650, the former metal trades storage area, stored unknown supplies for ship repair. The exact dates of operation are unknown, but maps indicate that the area was in operation during the 1970s. AOC 651, the former sandblasters storage area, stored sandblast media presumably resulting from ship repair from the 1970s until 1991.

Soil was sampled to assess the presence of residual contamination from the former storage area. Soil was sampled in accordance with Section 2.2. Potential groundwater contamination associated with these AOCs is addressed as SWMU 9.

4.9.1 Soil Sampling and Analysis

During primary soil sampling, nine soil samples were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. Two samples were duplicated and analyzed for herbicides, hexavalent chromium, organophosphate pesticides, dioxins, and TPH. Primary soil sampling locations were positioned based on the reported locations of two building/storage areas used by NAVBASE contractors. A second sampling round was conducted based on results of the first round. The 11 soil samples collected during the second round were analyzed for SVOCs, pesticides/PCBs, and metals. One of these samples was duplicated. Table 4.9.1 (organic) and Table 4.9.2 (inorganic) summarize the analytical data for the soil samples collected near the three AOCs. Figure 4.9.1 identifies soil sampling locations in the vicinity. Appendix I contains all analytical data for Zone H. Because AOCs 650 and 651 are close to each other, samples were identified with the prefix 650.

4.9.1.1 Volatile Organic Compounds in Soil

Soil samples for VOC analysis were collected from the 0- to 1-foot depth interval at AOCs 649, 650, and 651. VOCs were detected in soil samples collected at five of the nine initial sample locations at these three AOCs. Seven different VOCs were detected at concentrations ranging from two to seven orders of magnitude below their respective RBSLs.

4.9.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected in all nine primary sampling locations and four of the 11 secondary sampling locations. All but one were collected from the 0- to 1-foot depth interval. Twenty SVOCs were detected in the soil samples collected at AOCs 649, 650, and 651. Five were reported at concentrations exceeding the risk-based screening levels: benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Benzo(a)anthracene (RBSL-880 μg/kg), dibenzo(a,h)anthracene (RBSL-88 μg/kg), and indeno(1,2,3-cd)pyrene (RBSL-880 μg/kg) were detected above their respective RBSLs at only one location. A soil sample collected from location 650SB006 contained these three compounds at concentrations of 1,900 μg/kg, 390 μg/kg, and 910 μg/kg, respectively. Benzo(b)flouranthene (RBSL-880 μg/kg) was also detected above the RBSL at sample location 650SB006 as well as location 650SB004 at concentrations of 4,000 μg/kg and 1,660 μg/kg, respectively.

4.9.1.3 Pesticides and PCBs in Soil

Pesticides were detected in four of the nine primary sampling locations and five of the 11 secondary sampling locations. Six pesticides were detected in the soil samples collected at AOC 649, 650, and 651. Alpha-chlordane and 4,4' DDE were the most commonly detected pesticides. All pesticide concentrations detected ranged from one to four orders of magnitude below their respective RBSLs.

PCBs were detected in one of the nine primary sampling locations, and four of the 11 secondary sampling locations. Two PCB compounds were reported in the soil samples collected

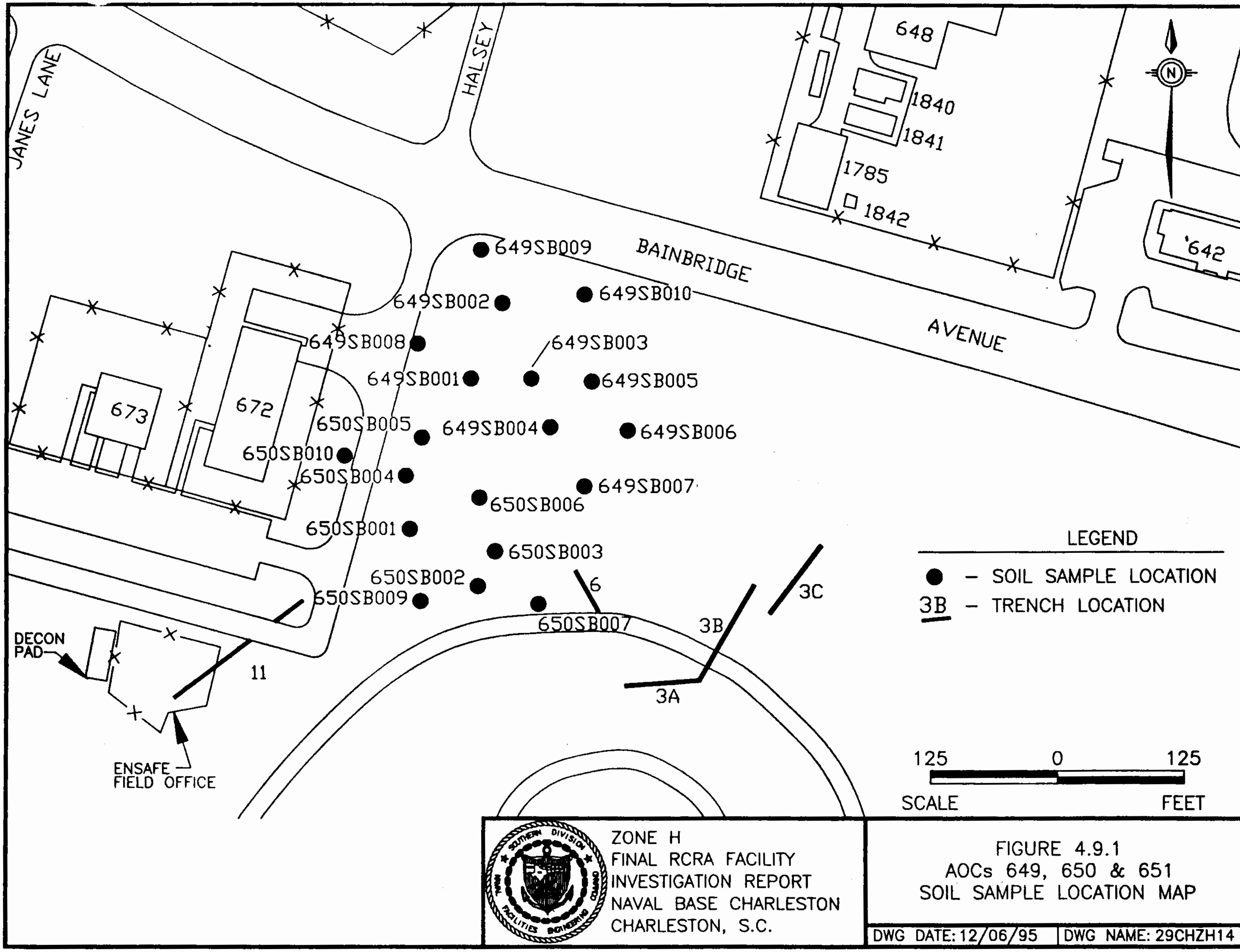

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FIGURE 4.9.1
AOCs 649, 650 & 651
SOIL SAMPLE LOCATION MAP

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at AOCs 649, 650, and 651. Aroclor-1254 exceeded its RBSL of 83 μg/kg at 650SB002 with a concentration of 407 μg/kg. Other PCB compound concentrations were below their respective RBSLs.

4.9.1.4 Other Organic Compounds in Soil

Petroleum hydrocarbons were detected in the two duplicate samples from locations 649SB001 and 650SB003 at concentrations of 160,000 μg/kg and 980,000 μg/kg, respectively. No other samples were analyzed for TPH.

No herbicides or organophosphate pesticides were detected in the three duplicate samples which were also analyzed for dioxin. TEQs for dioxin (screening level 1,000 pg/g) ranged from 0.967 pg/g to 8.382 pg/g for samples collected at AOC 649, 650, and 651.

4.9.1.5 Inorganic Elements in Soil

Inorganics that exceeded their RBSLs and UTLs for background at AOCs 649, 650, and 651 are copper and mercury. Copper was detected in a sample collected at location 650SB006 at a concentration of 357 mg/kg. The RBSL and upper-interval UTL for copper are 290 mg/kg and 27.6 mg/kg, respectively. Mercury was detected in a sample collected at location 650SB010 at a concentration of 6.9 mg/kg. The RBSL and upper-interval UTL for mercury are 2.3 mg/kg and 0.485 mg/kg, respectively.

Cyanide was not detected in soil samples collected at any of the nine sample locations.

No hexavalent chromium was not detected in the three duplicate samples.

4.9.2 Deviations from Final Zone H RFI Work Plan

Eighteen soil samples were proposed for collection in the Final Zone H RFI Work Plan. The actual number of soil samples collected at AOCs 649, 650, and 651 was 20 (19 upper interval, one lower interval). All proposed upper interval samples were collected. Due to shallow depth to groundwater, only some of the second interval samples were collected from the proposed locations. Based on analytical data for soil samples collected during the initial phase of sampling, additional sample locations were identified. Sampling was attempted for both intervals at each of these additional locations. As with the initial phase of sampling, some of the second interval samples at the additional locations were not collected due to shallow depth to groundwater.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.9.1
AOCs 649, 650, and 651
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds *(10 Samples Collected — 10 Upper Interval Samples, 3 Samples Duplicated)*			
Acetone	1/0	25.2/0	780,000
Carbon disulfide	1/0	4.8/0	780,000
Chlorobenzene	2/0	1.8-5.18/0	160,000
1,1-Dichloroethene	1/0	1.9/0	1,100
Toluene	4/0	2.4-5.9/0	160,000
Xylene (total)	1/0	7.1/0	16,000,000
Acrylonitrile[a]	2/0	5.8-36.9/0	1,200
Semivolatile Organic Compounds *(20 Samples Collected — 19 Upper Interval Samples, 1 Lower Interval Sample, 3 Samples Duplicated)*			
Anthracene	3/0	77.9-250/0	2,300,000
Benzoic acid	5/0	76.9-269/0	31,000,000
Benzo(a)anthracene	9/0	85.9-1,900/0	880
Benzo(b)fluoranthene	8/0	130-4,000/0	880
Benzo(k)fluoranthene	2/0	83.1-130/0	8,800
Benzo(a)pyrene	8/0	80.3-2,000/0	88
Benzo(g,h,i)perylene	4/0	94.3-1,100/0	310,000
BEHP	6/0	100-504/0	4,600
Butylbenzylphthalate	6/0	66-1,540/0	1,600,000
Chrysene	9/0	60.6-1,900/0	88,000
Dibenzo(a,h)anthracene	2/0	72.1-390/0	88
Dibenzofuran	2/0	42.9-56.5/0	31,000
Di-n-butylphthalate	8/0	68.9-222/0	780,000
Di-n-octylphthalate	1/0	98/0	160,000
Fluoranthene	10/0	110-3,200/0	310,000
Indeno(1,2,3-cd)pyrene	4/0	62.5-910/0	880

Table 4.9.1
AOCs 649, 650, and 651
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Levels
Semivolatile Organic Compounds ***(20 Samples Collected — 19 Upper Interval Samples, 1 Lower Interval Sample, 3 Samples Duplicated)***			
2-Methylnaphthalene	5/0	99.1-322/0	310,000
Naphthalene	5/0	66.5-270/0	310,000
Phenanthrene	11/0	65.5-800/0	310,000
Pyrene	11/0	86.9-3,300/0	230,000
Pesticides ***(20 Samples Collected — 19 Upper Interval Samples, 1 Lower Interval Sample, 3 Samples Duplicated)***			
alpha-Chlordane	7/1	1.8-11.6/2.0	470 alpha + gamma
gamma-Chlordane	2/0	1.3-6/0	
4,4'-DDD	2/0	2.4-8/0	2,700
4,4'-DDE	5/1	6-10.2/3.0	1,900
4,4'-DDT	2/0	6-7/0	1,900
Endosulfan sulfate	1/0	7/0	47,000
Polychlorinated Biphenyls ***(20 Samples Collected — 19 Upper Interval Samples, 1 Lower Interval Sample, 3 Samples Duplicated)***			
Aroclor-1248	1/1	52/30	83
Aroclor-1254	4/1	30-407/30	83
Total Petroleum Hydrocarbons ***(2 Duplicate Analyses — 2 Upper Interval Samples)***			
Total Petroleum Hydrocarbon (IR)	2/0	160,000-980,000/0	not listed
Herbicides ***(3 Duplicate Analyses — 3 Upper Interval Samples)***			
No herbicides detected.			
Organophosphate Pesticides ***(3 Duplicate Analyses — 3 Upper Interval Samples)***			
No organophosphates detected.			
Dioxin ***(3 Duplicate Analyses — 3 Upper Interval Samples)***			
Total TEQ Values	3/0	0.967-8.382/0 pg/g	1000 pg/g

Note:
(a) = Compound included in the Appendix IX analysis but not in the SW-846 analysis.

Table 4.9.2
AOC 649, 650, and 651
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	19/1	19/1	1,960-10,900/3,280	7,900	25,310/46,180
Iron[a]	19/1	19/1	1,640-16,200/2,860	Not Listed	30,910/66,170
Lead	19/1	18/1	3.6-347/13.9	400	118/68.69
Nickel	19/1	19/1	0.93-39.2/5.7	160	33.38/29.9
Potassium[a]	19/1	11/0	95.2-819/0	Not Listed	Nutrient[e]
Sodium[a]	19/1	18/1	33.1-308/26.8	Not Listed	Nutrient[e]
Thallium	19/1	2/0	0.49-0.54/0	0.63	0.63/1.3
Antimony	19/1	4/0	0.74-1.6/0	3.1	Not Valid[d]
Arsenic	19/1	9/1	2.1-9.5/3.0	0.37	14.81/35.52
Barium	19/1	10/0	8.9-57.9/0	550	40.33/43.80
Beryllium	19/1	19/1	0.08-1.1/0.2	0.15	1.466/1.62
Cadmium	19/1	11/0	0.13-0.39/0	3.9	1.05/1.10
Cobalt	19/1	18/1	0.57-9.5/1.5	470	5.863/14.88
Copper	19/1	14/1	6.7-357/24.6	290	27.6/31.62
Vanadium	19/1	19/1	5.3-35.4/8.4	55	77.38/131.6
Zinc	19/1	19/0	6.0-507/0	2,300	214.3/129.6
Selenium	19/1	5/0	0.22-0.42/0	39	2.0/2.7
Mercury	19/1	13/0	0.02-6.9/0	2.3	0.485/.74
Magnesium[a]	19/1	19/1	104-1,420/294	Not Listed	9,592/9,179
Manganese[a]	19/1	19/1	6.3-124/12.4	39	636.4/1,412
Calcium	19/1	19/1	717-114,000/8,280	Not Listed	Nutrient[e]
Chromium	19/1	19/1	4.5-24.4/12.3	39	85.65/83.86
Tin[a]	3/0	1/0	22.3/0	4,700	Not Valid[d]

Table 4.9.2
AOC 649, 650, and 651
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Hexavalent Chromium[b]	3/0	0/0	0/0	39	Not Valid[d]
Cyanide	9/3	0/0	0/0	160	Not Valid[d]

Notes:

(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTLs.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

4.10 AOC 656

AOC 656 is the site of a 1974 oil spill between Buildings 602 and NS-71. This spill resulted from a ruptured underground line connecting an 8,000-gallon aboveground storage tank (AST) in Building 602 to a boiler in Building NS-71. Of the 285 gallons released during the spill, 275 gallons were reported to be recovered.

Soil and groundwater were sampled at AOC 656 to determine the residual contamination from the previous oil spill and other possible spills which may have occurred at the AST.

4.10.1 Soil Sampling and Analysis

Soil sampling was conducted in two phases at AOC 656 along the previously ruptured pipeline and near the AST. Locations were selected to detect possible residual contamination from the reported spill or contamination from other spills which may have occurred at the AST. During the primary soil sampling event, 14 soil samples were collected from nine locations. Nine soil samples were collected from the 0- to 1-foot depth interval and five samples were collected from the 3- to 5-foot depth interval with hand augers as described in Section 2.2.2. Samples were analyzed for VOCs, SVOCs, cyanide, metals, TPH, and pesticides/PCBs. Two samples selected for duplicate analysis were analyzed for hexavalent chromium, herbicides, organophosphate pesticides, and dioxins in addition to the standard suite of analyses. During the second sampling event, two soil samples were collected from each depth interval (0- to 1-foot and 3- to 5-feet) at two additional locations and analyzed for SVOCs only. One of these samples was submitted for duplicate analysis. Sample locations for both sampling events are shown on Figure 4.10.1. Tables 4.10.1 and 4.10.2 summarize the organic and inorganic data, respectively. A complete report of analytical data for soil samples collected in the vicinity of AOC 656 is included as Appendix I.

4.10.1.1 Volatile Organic Compounds in Soil

Acetone, the only VOC detected in the AOC 656 soil samples, was detected in one of the 14 soil samples analyzed. Laboratory analysis of the sample collected at sample location 656SB002 (from the 3- to 5-foot depth interval) indicated acetone at a concentration of 210 μg/kg, three orders of magnitude lower than its RBSL.

4.10.1.2 Semivolatile Organic Compounds in Soil

Fifteen semivolatile organic compounds were detected at six of the nine primary sample locations, one of the two secondary sample locations, and in eight of all 18 samples analyzed. Of the eight SVOCs detections, five were from the 0- to 1-foot depth interval and three were from the 3- to 5-foot depth interval. One compound, benzo(a)pyrene, was detected at a concentration exceeding its RBSL. This compound was detected in the 0- to 1-foot sample interval at sample locations 656SB001, 656SB009, and 656SB011.

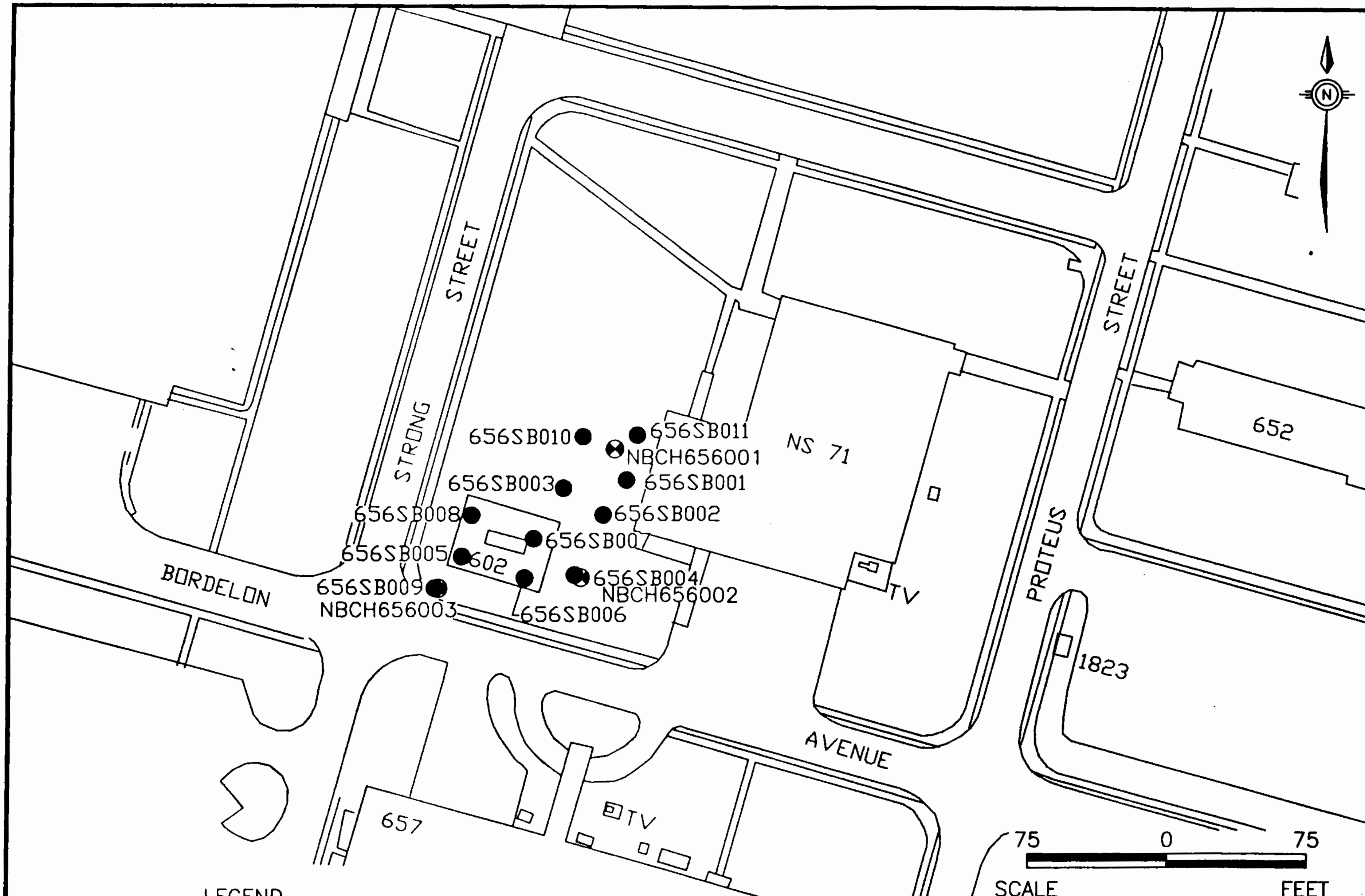
4.10.1.3 Pesticides and PCBs in Soil

Six different pesticides were detected in soil samples from four of the 11 primary sampling locations and in five of the 14 samples analyzed. Pesticides were detected in four of the nine samples collected from the 0- to 1-foot depth interval and from one of the five samples collected from the 3- to 5-foot depth interval. Pesticide concentrations ranged from two to four orders of magnitude below RBSLs.

No PCBs were detected in the soil samples collected at AOC 656.

4.10.1.4 Other Organic Compounds in Soil

TPH analysis identified petroleum hydrocarbons at six of the 11 primary sample locations in six of the 14 samples analyzed. Petroleum hydrocarbons were detected in the 0- to 1-foot depth interval at sample locations 656SB004 through 656SB009, at concentrations ranging from 81,000 μg/kg to 1,900,000 μg/kg. Samples collected near the previously ruptured pipeline did



LEGEND

● – SOIL SAMPLE LOCATION

⊗ – GROUNDWATER SAMPLE LOCATION

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.10.1
AOC 656
SOIL & GROUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH12

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not contain petroleum hydrocarbons above detection limits. However, samples from near the AST had petroleum hydrocarbons above detection limits with the highest concentrations nearest the AST.

One herbicide compound (2,4,5-TP [Silvex]) was detected in two duplicate soil samples from locations 656SB002 and 656SB009. Silvex concentrations were four orders of magnitude below the RBSL.

No organophosphate compounds were detected in the soil samples collected at AOC 656.

TEQs for dioxin ranged from 1.359 pg/g to 4.577 pg/g (screening level 1,000 pg/g) for duplicate samples collected at AOC 656.

4.10.1.5 Inorganic Elements in Soil

Table 4.10.2 summarizes the inorganic results from AOC 656 soil samples. The only element with a detected concentration exceeding its RBSL and interval-specific UTL was manganese in the upper interval of 656SB006.

No cyanide or hexavalent chromium was detected in the soil samples collected at AOC 656.

4.10.2 Groundwater Sampling and Analysis

Three monitoring wells were installed to sample groundwater in the vicinity of AOC 656 (see Figure 4.10.1). Groundwater samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH during first-round sampling. One groundwater sample was duplicated and analyzed for hexavalent chromium, herbicides, organophosphate pesticides, and dioxins, in addition to the standard suite of analyses. Second-round samples were analyzed for VOCs and metals, based on the first-round sample results. One sample from the second round was duplicated and analyzed for the same parameters as the primary samples. Tables 4.10.3

and 4.10.4 summarize the organic and inorganic results respectively, for groundwater. A complete report of analytical data for groundwater samples collected at AOC 656 is included in Appendix I.

4.10.2.1 Volatile Organic Compounds in Groundwater

No VOCs were detected in groundwater samples collected in the first or second sampling rounds from wells at AOC 656.

4.10.2.2 Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in samples collected at AOC 656.

4.10.2.3 Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in samples collected at AOC 656.

4.10.2.4 Other Organic Compounds in Groundwater

No herbicides, organophosphate pesticides, or petroleum hydrocarbons were detected in samples collected at AOC 656.

Total TEQs were 1.747 pg/L for the dioxin analysis of the duplicate sample collected from NBCH656001 (dioxin RBSL-0.5 pg/L).

4.10.2.5 Inorganic Elements in Groundwater

Table 4.10.4 summarizes the results for inorganic elements in groundwater samples collected at AOC 656. Elements exceeding their corresponding RBSLs are arsenic, manganese, and thallium. Two of 10 metals detected in first-round samples exceeded their RBSLs. Arsenic (RBSL-0.038 μg/L) was reported at a concentration of 18 μg/L from monitoring well NBCH656001. Manganese (RBSL-18μg/L) was detected at concentrations of 153, 174, and 454 μg/L in first-round samples from wells NBCH656001, NBCH656002, and NBCH656003, respectively. In second-round samples 14 metals were detected, with three above RBSLs. Arsenic was found at 3.1 μg/L in the sample from well NBCH656003. Manganese concentrations in second-round samples from NBCH656001 through NBCH656003 were 128, 262, and 835 μg/L, respectively. Thallium (RBSL-0.029 μg/L) was detected in only one well, NBCH656003, in a second-round groundwater sample at a concentration of 4.1 μg/L. None of the detections for arsenic, manganese, or thallium exceeded their corresponding UTLs in either sampling round.

No cyanide or hexavalent chromium was detected in the samples collected at AOC 656.

4.10.3 Deviations from Final Zone H RFI Work Plan

Eighteen soil samples were proposed to be collected in the Final Zone H RFI Work Plan. The actual number of soil samples collected at AOC 656 was 17 (11 upper interval, six lower interval). All upper-interval samples were collected. Due to shallow depth to groundwater, only some of the lower-interval samples were collected from the proposed locations. Based on analytical data for soil samples collected during the initial phase of sampling, additional sample locations were identified. Samples were collected from both sampling intervals at each of these additional sample locations.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.10.1
AOC 656
Organic Compounds in Soil (in µg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(14 Samples Collected — 9 Upper Interval Samples, 5 Lower Interval Samples, 2 Samples Duplicated)***			
Acetone	0/1	0/210	780,000
Semivolatile Organic Compounds ***(18 Samples Collected — 11 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)***			
Acenaphthene	1/0	180/0	470,000
Anthracene	1/0	250/0	2,300,000
Benzo(a)anthracene	3/0	163-620/0	880
Benzo(b)fluoranthene	3/0	130-430/0	880
Benzo(k)fluoranthene	3/0	170-430/0	8,800
Benzo(g,h,i)perylene	2/0	127-240/0	310,000
Benzo(a)pyrene	3/0	140-460/0	88
bis(2-Ethylhexyl)phthalate (BEHP)	1/0	280/0	46,000
Chrysene	3/1	164-580/230	88,000
Fluorene	1/1	180/270	310,000
Fluoranthene	5/1	120-1,300/110	310,000
Indeno(1,2,3-cd)pyrene	2/0	111-240/0	880
Phenanthrene	4/1	100-1,100/780	310,000
Phenol	0/1	0/170	4,700,000
Pyrene	5/2	92-970/94-280	230,000
Pesticides ***(14 Samples Collected — 9 Upper Interval Samples, 5 Lower Interval Samples, 2 Samples Duplicated)***			
4,4'-DDD	0/1	0/6.0	2,700
4,4'-DDE	3/1	3-10/3	1,900
4,4'-DDT	1/0	2.7/0	1,900
alpha-Chlordane	4/0	1.8-6/0	470 alpha+gamma
gamma-Chlordane	4/0	1.1-6/0	470
Endosulfan II	1/0	3.2/0	47,000
Polychlorinated Biphenyls ***(14 Samples Collected — 9 Upper Interval Samples, 5 Lower Interval Samples, 2 Samples Duplicated)***			
No PCBs detected.			
Total Petroleum Hydrocarbons ***(14 Samples Collected — 9 Upper Interval Samples, 5 Lower Interval Samples, 2 Samples Duplicated)***			
Total Petroleum Hydrocarbons	6/0	8,1000-1,900,000/0	Not Listed

Table 4.10.1
AOC 656
Organic Compounds in Soil (in $\mu g/kg$)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Herbicides *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
2,4,5-TP (Silvex)	2/0	7.3-8.4/0	63,000
Organophosphate Pesticides *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
No organophosphates detected.			
Dioxins *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
Total TEQ	2/0	1.359-4.577 pg/g	1,000 pg/g

Table 4.10.2
AOC 656
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	9/5	9/5	1,940-17,400/5,200-12,800	7,900	25,310/46,180
Iron[a]	9/5	9/5	1,550-27,500/3,330-28,100	Not Listed	30,910/66,170
Lead	9/5	3/2	27.3-40/29.1-30.6	400	118/68.69
Nickel	9/5	4/0	0.88-12.8/0	160	33.38/29.9
Potassium[a]	9/5	2/3	753-1650/732-1710	Not Listed	Nutrient[e]
Sodium[a]	9/5	9/5	48.6-696/85.8-1700	Not Listed	Nutrient[e]
Arsenic	9/5	9/5	0.56-14.8/1.8-14.2	0.37	14.81/35.52
Barium	9/5	4/4	7.8-25.8/14.1-20.7	550	40.33/43.80
Beryllium	9/5	4/3	0.03-0.92/0.4-0.89	0.15	1.466/1.62
Cadmium	9/5	0/0	0/0	7.8	1.05/1.10
Cobalt	9/5	3/2	0.34-5.5/4.8-4.8	470	5.863/14.88
Copper	9/5	9/5	1.9-27.8/1.8-16.5	290	27.6/31.62
Vanadium	9/5	9/5	2.9-56.1/8.5-51.8	55	77.38/131.6
Zinc	9/5	7/3	3.9-306.7/23.8-58.9	2,300	214.3/129.6
Selenium	9/5	3/3	0.11-0.72/0.27-1.0	39	2.0/2.7
Mercury	9/5	5/1	0.04-0.26/0.14	2.3	0.485/.74
Magnesium[a]	9/5	9/5	141-3460/474-3610	Not Listed	9,592/9,179
Manganese[a]	9/5	9/5	8.8-719/40.7-579	39	636.4/1,412
Calcium	9/5	9/5	3190-48800/2380-55200	Not Listed	Nutrient[e]
Chromium	9/5	9/5	5.65-41.8/7.7-33.7	39	85.65/83.86
Tin[a]	2/0	1/0	5.8/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	2/0	0/0	0/0	39	Not Valid[d]
Cyanide	9/5	0/0	0/0	160	Not Valid[d]

Notes:
[a] = Elements that are not included in both SW-846 and Appendix IX methods.
[b] = Included in duplicate sample analyses only.
[c] = See Appendix J for UTL determination.
[d] = Number of nondetections prevented determination of UTL.
[e] = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.10.3
AOC 656
Organic Elements in Groundwater (μg/L)

Round 1: 3 Samples Collected, 0 Samples Duplicated
Round 2: 3 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds (Collected in Rounds 1 and 2)					
No VOCs detected.					
Semivolatile Organic Compounds (Collected in Round 1 Only)					
No SVOCs detected.					
Pesticides (Collected in Round 1 Only)					
No pesticides detected.					
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Collected in Round 1 Only)					
No TPH detected.					
Herbicides (Collected in Round 1 Only)					
No herbicides detected.					
Organophosphate Pesticides (Collected in Round 1 Only)					
No organophosphate pesticides detected.					
Dioxins (Collected in Round 1 Only)					
Total TEQs	1	1	1.747 pg/L	0.5 pg/L	30 pg/L
	2	--	No Analysis		

Table 4.10.4
AOC 656
Inorganic Chemicals in Groundwater (μg/L)

Round 1: 3 Samples Collected, 0 Sample Duplicated
Round 2: 3 Samples Collected, 1 Sample Duplicated

Chemical Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[d]	1 2	1 2	672 33.9-206	3,700	Not Valid	Not Listed
Arsenic	1 2	1 1	18 3.1	0.038	27.99	50
Barium	1 2	2 3	8.4-55.4 9.3-83	260	323.0	2,000
Calcium[c]	1 2	3 3	75,700-257,000 68,550-298,000	Not Listed	Nutrient	Not Listed
Chromium[d]	1 2	0 1	– 2.0	18[e]	Not Valid	100
Iron	1 2	3 3	3,650-17,900 4,360-23,100	Not Listed	45,760	Not Listed
Magnesium	1 2	3 3	58,100-717,000 538,000-894,000	Not Listed	3,866,000	Not Listed
Manganese	1 2	3 3	153-454 127.5-835.0	18	3,391	Not Listed
Nickel[d]	1 2	0 1	– 27.5	73	Not Valid	100
Potassium[c]	1 2	3 3	35,700-172,000 31,250-222,000	Not Listed	Nutrient	Not Listed
Sodium[c]	1 2	3 3	479,000-5,330,000 418,500-6,230,000	Not Listed	Nutrient	Not Listed
Thallium	1 2	0 1	– 4.1	0.029[g]	7.660	2
Vanadium[d]	1 2	1 3	4.6 2.7-11.6	26	Not Valid	Not Listed
Zinc[d]	1 2	0 1	– 18.5	1,100	Not Valid	Not Listed
Cyanide[d]	1 2	– –	Not Detected No Analysis			
Hexavalent Chromium[d]	1 2	– –	Not Detected No Analysis			

Notes:

(a) = Only elements with detections are listed. Cyanide and hexavalent chromium were separate analyses.
(b) = See Appendix J for UTL determinations.
(c) = Element considered to be a nutrient; therefore, UTL was not determined.
(d) = High percentage of nondetects in background samples prevented determination of UTL.
(e) = If trivalent chromium, RBSL = 3700 μg/L.
(f) = Based on treatment technique action level.
(g) = Thallium carbonate used as surrogate.

4.11 AOC 653

AOC 653 is a hydraulic fluid storage tank at the west end of Building 1508 (one of the four buildings which make up the automotive hobby shop complex). The tank is no longer in use due to suspected leakage. In addition to fluids in the tank, various paints, solvents, thinners, and petroleum products used and stored at the site may have been released.

Soil and groundwater were sampled at AOC 653 to determine if residual contamination resulted from the leaking tank and other possible spills which may have occurred in the vicinity of AOC 653.

4.11.1 Soil Sampling and Analysis

Soil was sampled in accordance with procedures detailed in Section 2.2. Six first-round soil samples were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, TPH, and cyanide. One sample was duplicated and analyzed for herbicides, hexavalent chromium, dioxins, and organophosphate pesticides. A second round of eight soil samples was analyzed for SVOCs, pesticides, and dioxins. Soil was sampled in the immediate vicinity of the hydraulic tank to identify any contamination. Figure 4.11.1 identifies soil and groundwater sampling locations near AOC 653.

Analytical results for the soil samples are summarized in Table 4.11.1 (organic) and Table 4.11.2 (inorganic). A complete analytical report for AOC 653 soil samples is included in Appendix I.

4.11.1.1 Volatile Organic Compounds in Soil

VOCs were detected at all four sampling locations, and in all six samples analyzed. Of the six samples collected, four were from the 0- to 1-foot depth interval and two were from the 3- to 5-foot depth interval. Six VOCs (acetone, toluene, 2-butanone, acrylonitrile, 4-methyl-2-pentanone, and xylene) were detected in AOC 653 soil samples. VOC concentrations ranged from four to five orders of magnitude below respective RBSLs.

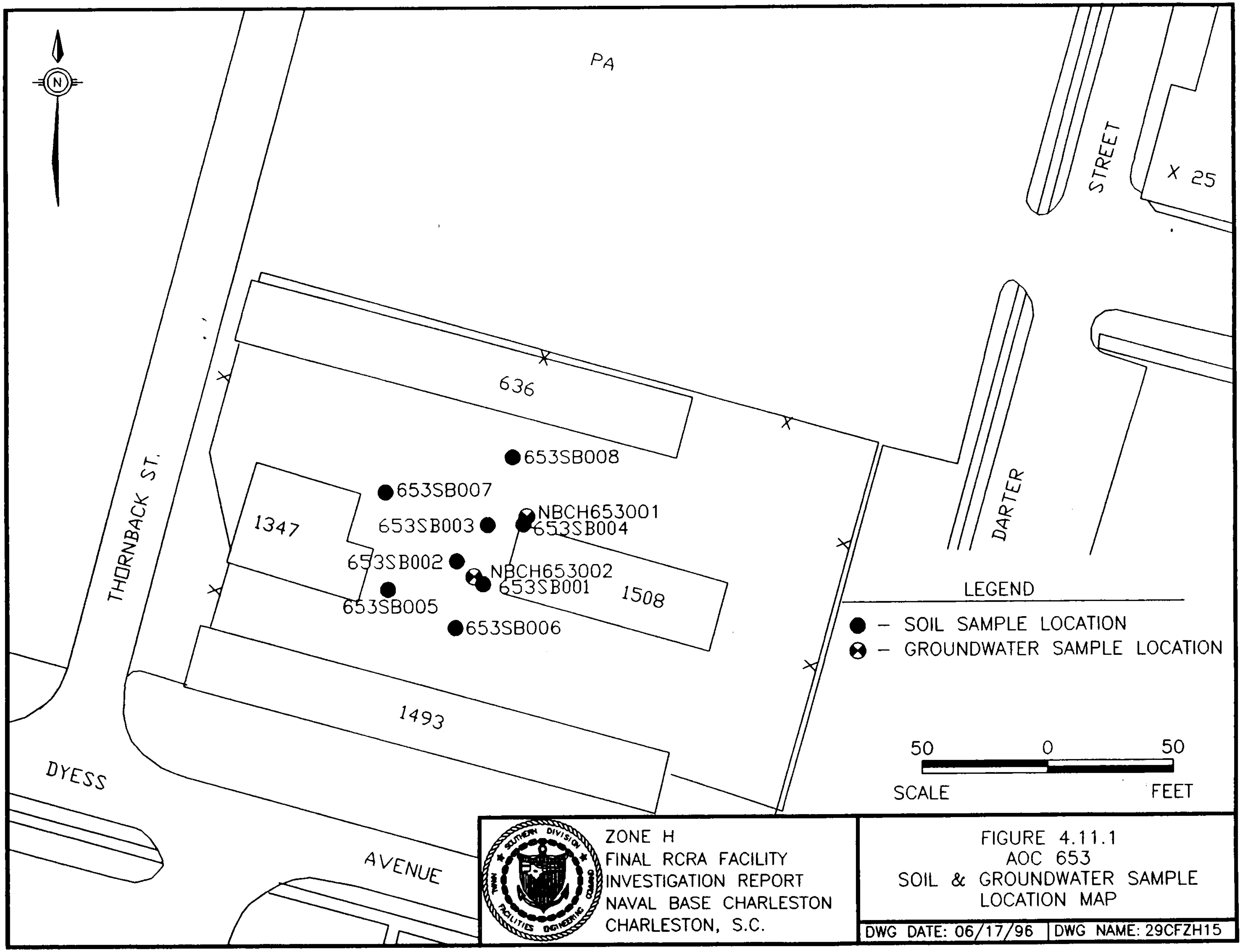
4.11.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected in seven of the 13 samples analyzed. Of the seven samples in which SVOCs were detected, five were collected from the 0- to 1-foot depth interval and two were collected from the 3- to 5-foot depth interval. Sixteen SVOCs were detected in the soil samples from AOC 653. Only one SVOC was detected above its RBSL at SWMU 653. Benzo(a)pyrene (RBSL-88 μg/kg) was detected in a soil sample collected from the 0- to 1-foot interval at location 653SB001 and in a sample from the 3- to 5-foot interval at location 653SB003. Except for benzo(a)anthracene and benzo(b)fluoranthene, the remaining compounds were detected between one and five orders of magnitude below respective RBSLs. Benzo(a)anthracene (RBSL-880 μg/kg) was detected up to 150 μg/kg and benzo(b)fluoranthene (also RBSL of 880-μg/kg) was detected up to 140 μg/kg.

4.11.1.3 Pesticides and PCBs in Soil

Pesticides were detected in nine of the 13 samples analyzed. Of these samples, eight were from the 0- to 1-foot interval and one was from the 3- to 5-foot interval. Four different pesticides were detected in the soil samples from AOC 653. Concentrations detected for these pesticides ranged between one and three orders of magnitude below respective RBSLs.

PCBs were detected in only one sample from all four locations. PCBs were detected in the soil sample from the 0- to 1-foot depth interval at sample location 653SB001. Aroclors-1248 and 1260 (RBSL-83 μg/kg) were detected in this sample at concentrations of 88 μg/kg and 71 μg/kg, respectively.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.11.1
AOC 653
SOIL & GROUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 06/17/96 | DWG NAME: 29CFZH15

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4.11.1.4 Other Organic Compounds in Soil

TPH analysis identified petroleum hydrocarbons at all four sample locations and in all six samples analyzed. Four were collected from the 0- to 1-foot interval and two were from the 3- to 5-foot interval. TPH concentrations ranged from 400,000 μg/kg to 42,000,000 μg/kg.

Herbicides and organophosphate pesticides analyses were conducted on a soil sample collected from the 0- to 1-foot depth at duplicate sample location 653SB003. One organophosphate pesticide, methyl parathion (RBSL-2,000 μg/kg), was present in this sample at 33.2 μg/kg.

Dioxins (screening level 1,000 pg/g) were reported in each of the nine samples submitted for dioxin analysis. TEQ concentrations for dioxin ranged from 1.489-43.411 pg/g in the upper interval and 0.541-8.068 pg/g in the lower interval.

4.11.1.5 Inorganic Elements in Soil

One element (lead) exceeded both its RBSL and interval-specific UTL in the soil at AOC 653. Lead was detected above both screening limits in samples collected from the 0- to 1-foot interval at sample locations 653SB001 and 653SB003 at concentrations of 561 mg/kg and 638 mg/kg, respectively. The lead detection at 653SB003 (638 μg/kg) was complemented by a duplicate sample analysis which also detected lead (483 μg/kg), resulting in an average of 561 μg/kg which is reflected in Table 4.11.2.

Cyanide was not detected in any of the six samples analyzed.

Hexavalent chromium was not detected in the soil sample submitted for duplicate analysis.

4.11.2 Groundwater Sampling and Analysis

Two monitoring wells were installed to sample shallow groundwater near AOC 653 (See Figure 4.11.1). Groundwater was sampled in accordance with procedures detailed in

Section 2.4, and was analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH in first-round samples. Based on the results from first-round sampling, second-round samples were analyzed for SVOCs, pesticides, and metals. One second-round sample was duplicated and analyzed for the same parameters as the primary samples. Tables 4.11.3 and 4.11.4 summarize organic and inorganic results, respectively, for groundwater. Appendix I contains a complete report of analytical data for groundwater samples collected at AOC 653.

4.11.2.1 Volatile Organic Compounds in Groundwater

No VOCs were detected in the groundwater samples collected at AOC 653 in the first or second sampling rounds.

4.11.2.2 Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in the first-round or second-round groundwater samples collected at AOC 653.

4.11.2.3 Pesticides and PCBs in Groundwater

One pesticide compound was detected in a first-round groundwater sample from one of the two monitoring wells installed at AOC 653. The pesticide 4,4'-DDT (RBSL-0.2 μg/L) was detected in monitoring well NBCH653001 at a concentration of 0.06 μg/L. No PCBs were detected in any first-round groundwater samples from AOC 653.

No pesticides were detected in second-round groundwater samples collected at AOC 653. PCB analysis was not performed on second-round samples.

4.11.2.4 Other Organic Compounds in Groundwater

No petroleum hydrocarbons were detected in groundwater samples collected at AOC 653.

4.11.2.5 Inorganic Elements in Groundwater

Manganese (RBSL-18 μg/L), thallium (RBSL-0.029μg/L), and arsenic (RBSL-0.038 μg/L) were the only inorganic elements detected in AOC 653 groundwater samples that exceeded their RBSLs. Manganese was detected at concentrations of 672 and 90.6 μg/L in first-round samples from wells NBCH653001 and NBCH653002, respectively. In second-round samples from NBCH653001 and NBCH653002, manganese appeared at concentrations of 680 and 128 μg/L, respectively. Thallium was detected in a first-round sample from well NBCH653001 at a concentration of 1.2 μg/L, but not in second-round samples from either well. Arsenic was not detected in either of the first-round samples, but was detected in the second-round sample from monitoring well NBCH653001 at a concentration of 36.55 μg/L. This arsenic value exceeded the UTL for arsenic as well as its RBSL. All values of manganese and thallium were below their corresponding UTLs.

4.11.3 Deviations from Final Zone H RFI Work Plan

Eight soil samples were proposed to be collected in the Final Zone H RFI Work Plan. The actual number of soil samples collected at AOC 653 was 14 (8 upper interval, 6 lower interval). The upper interval samples at each proposed location were collected. Due to shallow depth to groundwater, only two of the proposed second interval samples were collected. Based on analytical data for soil samples collected during the initial phase of sampling, additional sample locations were identified. Both sampling intervals were collected at each of these additional sample locations.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.11.1
AOC 653
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st interval/2nd interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(6 Samples Collected — 4 Upper Interval Samples, 2 Lower Interval Samples, 1 Sample Duplicated)***			
Acetone	4/2	25-131.5/76-83	780,000
2-Butanone (MEK)	1/2	23.4/13-14	4,700,000
4-Methyl-2-Pentanone (MIBK)	1/0	1.6/0	390,000
Toluene	4/1	6-20/7	1,600,000
Xylene (total)	1/0	2.2/0	16,000,000
Acrylonitrile[a]	1/0	23.9/0	1,200
Semivolatile Organic Compounds ***(12 Samples Collected — 7 Upper Interval Samples, 5 Lower Interval Samples, 2 Samples Duplicated)***			
Benzo(a)anthracene	0/2	0/100-150	880
Benzo(b)fluoranthene	0/2	0/120-140	880
Benzo(k)fluoranthene	0/1	0/190	8,800
Benzo(a)pyrene	1/1	110/140	88
BEHP	4/1	110-6,695/110	46,000
4-Bromophenyl-phenylether	0/1	0/500	450,000
Butylbenzylphthalate	1/0	110/0	1,600,000
Chrysene	0/2	0/100-160	88,000
Fluorene	1/0	441/0	310,000
Fluoranthene	0/2	0/170-260	310,000
2-Methylnaphthalene	1/0	1,520/0	310,000
4-Methylphenol	1/0	260/0	39,000
Naphthalene	1/0	739/0	310,000
4-Nitrophenol	0/1	0/2,500	480,000
Phenanthrene	1/2	711/170-200	310,000
Pyrene	2/2	110-801/290-370	230,000

Table 4.11.1
AOC 653
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st interval/2nd interval)	Risk-Based Screening Levels
Pesticides *(12 Samples Collected — 7 Upper Interval Samples, 5 Lower Interval Samples, 2 Samples Duplicated)*			
4,4'-DDD	6/1	8-180/9	2,700
4,4'-DDE	7/1	5.8-320/8	1,900
alpha-Chlordane	2/0	2-2/0	470 alpha + gamma
gamma-Chlordane	3/0	3-4/0	
Polychlorinated Biphenyls *(13 Samples Collected — 8 Upper Interval Samples, 5 Lower Interval Samples, 1 Sample Duplicated)*			
Aroclor-1248	1/0	88/0	83
Aroclor-1260	1/0	71/0	83
Petroleum Hydrocarbons *(6 Samples Collected — 4 Upper Interval Samples, 2 Lower Interval Samples, 1 Sample Duplicated)*			
Total Petroleum Hydrocarbons (IR)	5/2	730,000-42,000,000/400,000-440,000	Not Listed
Herbicides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No herbicides detected.			
Organophosphate Pesticides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
Methyl parathion	1/0	33.2/0	2000
Dioxins *(9 Samples Collected — 5 Upper Interval Samples, 4 Lower Interval Samples*			
Total TEQ Values	5/4	1.489-43.411pg/g/ 0.541-8.068 pg/g	1000 pg/g

Note:
(a) = Compound included in the Appendix IX analysis but not in the SW-846 analysis.

Table 4.11.2
AOC 653
Inorganic Elements in Soil (in mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	4/2	4/2	2,590-4,580/10,100-13,400	7,900	25,310/46,180
Iron[a]	4/2	4/2	3,520-9,050/16,700-19,900	Not Listed	30,910/66,170
Lead	4/2	4/2	38.2-561/44.2-53.5	400	118/68.69
Nickel	4/2	4/2	5.5-12.7/8.1-8.3	160	33.38/29.9
Potassium[a]	4/2	0/0	0/0	Not Listed	Nutrient[e]
Silver	4/2	0/0	0/0	39	Not Valid[d]
Sodium[a]	4/2	4/2	117-460/865-1,460	Not Listed	Nutrient[e]
Thallium	4/2	0/0	0/0	0.63	0.63/1.3
Antimony	4/2	0/0	0/0	3.1	Not Valid[d]
Arsenic	4/2	4/2	4.7-9.3/14.1-14.9	0.37	14.81/35.52
Barium	4/2	3/2	36.1-49.8/20.6-24.2	550	40.33/43.80
Beryllium	4/2	4/2	0.26-0.39/0.72-0.75	0.15	1.466/1.62
Cadmium	4/2	3/0	0.70-0.94/0	3.9	1.05/1.10
Cobalt	4/2	4/2	1.9-5.4/4.7-4.9	470	5.863/14.88
Copper	4/2	4/2	7.7-25.35/17.2-18	290	27.6/31.62
Vanadium	4/2	4/2	12-18/38.3-39.9	55	77.38/131.6
Zinc	4/2	4/2	55.3-165.5/68.4-78.8	2,300	214.3/129.6
Selenium	4/2	0/0	0/0	39	2.0/2.7
Mercury	4/2	4/2	0.03-0.22/0.23-0.24	2.3	0.485/.74
Magnesium[a]	4/2	4/2	430-2,470/2,920-3,000	Not Listed	9,592/9,179
Manganese[a]	4/2	4/2	27.8-233/172-418	39	636.4/1,412
Calcium	4/2	4/2	18,400-225,000/9,020-12,000	Not Listed	Nutrient[e]
Chromium	4/2	4/2	11.5-18.2/21-23.5	39	85.65/83.86
Tin[a]	1/0	0/0	0/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	1/0	0/0	0/0	39	Not Valid[d]
Cyanide	4/2	0/0	0/0	160	Not Valid[d]

Notes:

(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTL.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.11.3
AOC 653
Organic Compounds in Groundwater (μg/L)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds (Collected in Round 1 Only)					
No VOCs detected.					
Semivolatile Organic Compounds (Collected in Rounds 1 and 2)					
No SVOCs detected.					
Pesticides (Collected in Rounds 1 and 2)					
4,4'-DDT	1	1	0.06	0.2	
	2	0	--		
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Collected in Round 1 Only)					
No TPH detected.					

Table 4.11.4
AOC 653
Inorganic Elements in Groundwater (μg/L)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[c]	1	0	--	3,700	Not Valid	Not Listed
	2	2	189-248			
Arsenic	1	0	--	0.038	27.99	50
	2	1	36.55			
Calcium[d]	1	2	44,300-108,000	Not Listed	Nutrient	Not Listed
	2	2	567,000-942,000			
Iron	1	2	6,230-9,280	Not Listed	45,760	Not Listed
	2	2	9,510-10,550			
Magnesium	1	2	59,900-86,200	Not Listed	3,866,000	Not Listed
	2	2	60,600-66,850			
Manganese	1	2	90.6-672	18	3,391	Not Listed
	2	2	128-680			
Potassium[d]	1	2	52,300-58,200	Not Listed	Nutrient	Not Listed
	2	2	37,850-44,300			
Selenium	1	2	0.9-1.2	18	3.154	50
	2	0	--			
Sodium[d]	1	2	598,000-707,000	Not Listed	Nutrient	Not Listed
	2	2	476,500-539,000			
Thallium	1	1	1.2	0.29[e]	7.660	2
	2	0	--			
Vanadium[c]	1	1	4.6	26	Not Valid	Not Listed
	2	0	--			
Cyanide[c]	1	--	Not Detected			
	2	--	No Analysis			

Notes:
[a] = Only elements with detections are listed. Cyanide was a separate analysis.
[b] = See Appendix J for UTL determinations.
[c] = High percentage of nondetects in background samples prevented determination of UTL.
[d] = Element considered to be a nutrient; therefore, UTL was not determined.
[e] = Thallium carbonate used as surrogate.

4.12 AOC 654

AOC 654 is an abandoned septic tank and associated drain field connected to Building 661. It was used from 1968 until 1978 and was known to back up during high use, releasing raw sewage.

Soil was sampled to determine if contamination was associated with materials possibly disposed of in the septic system. Possible groundwater contamination associated with AOC 654 will be investigated as SWMU 9.

4.12.1 Soil Sampling and Analysis

Soil was sampled in accordance with procedures detailed in Section 2.2. Eleven soil samples collected at AOC 654 during the primary sampling event were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. One sample was duplicated and analyzed for herbicides, hexavalent chromium, dioxins, and organophosphate pesticides. The primary soil sampling locations were based on areas most likely to have been impacted if a release occurred. Figure 4.12.1 identifies AOC 654 soil sampling locations. Tables 4.12.1 (organic) and 4.12.2 (inorganic) summarize analytical data for soil samples collected at AOC 654. A complete analytical report for soil samples collected at AOC 654 is presented in Appendix I.

4.12.1.1 Volatile Organic Compounds in Soil

VOCs were detected in all six sampling locations, and in 10 of the 11 samples analyzed. Of the 10 samples in which VOCs were detected, six were from the 0- to 1-foot depth interval and four were from the 3- to 5-foot depth interval. Six VOCs were detected in the soil samples collected at AOC 654. VOC concentrations ranged from three to five orders of magnitude below their respective RBSLs.

4.12.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected at four of the six sampling locations, and four of all 11 samples analyzed. Of the four samples in which SVOCs were detected, three were from the 0- to 1-foot depth interval and one was from the 3- to 5-foot depth interval. Four SVOCs were detected in the soil samples from AOC 654. Except for benzo(a)anthracene and benzo(b)fluoranthene, concentrations ranged from one to two orders of magnitude below their respective RBSLs.

Benzo(a)anthracene and benzo(b)fluoranthene (RBSL-880 μg/kg) were detected at 140 μg/kg and 110 μg/kg, respectively.

4.12.1.3 Pesticides and PCBs in Soil

Pesticides were detected at one of the six soil sample locations, and in one of all 11 samples analyzed. The pesticide detection was from the 0- to 1-foot depth interval at location 654SB001. Pesticides were detected in this sample at concentrations ranging from one to three orders of magnitude below their respective RBSLs.

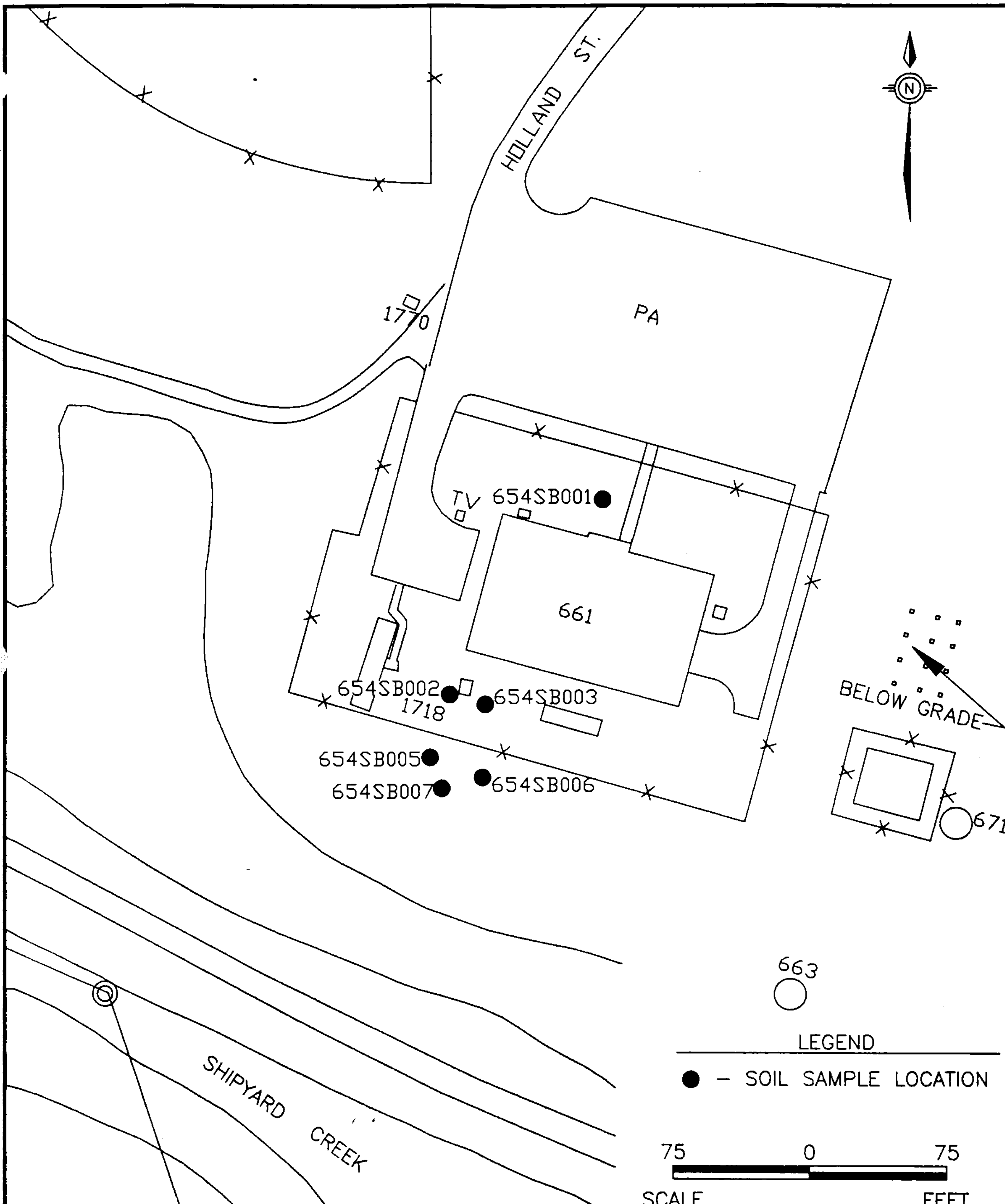
PCBs were not detected in any soil samples.

4.12.1.4 Other Organic Compounds in Soil

TPH analysis did not identify petroleum hydrocarbons in the duplicate sample.

Herbicides, hexavalent chromium, and organophosphate pesticides were not detected in the one duplicate sample collected.

One duplicate sample was analyzed for dioxins (screening level 1,000 μg/kg). The TEQ for dioxin for this sample was 0.717 pg/g.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON ,S.C.

FIGURE 4.12.1
AOC 654
SOIL SAMPLE LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH16

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4.12.1.5 Inorganic Elements in Soil

No elements were detected in the AOC 654 soil samples at concentrations that exceeded their RBSLs and interval-specific UTLs. However, magnesium was detected in one lower interval sample at a concentration (10,400 mg/kg) over its interval-specific UTL (9,179 mg/kg). No RBSL was available for magnesium.

Cyanide was detected in two of the six soil sample locations, and in two of all 11 samples analyzed. Cyanide (RBSL-160 mg/kg) was detected in a soil sample collected from the 0- to 1-foot interval at sample location 654SB007 and from the 3- to 5-foot depth interval at location 654SB006. Cyanide concentrations in these samples were 2.0 mg/kg and 1.0 mg/kg, respectively, which is two orders of magnitude below its RBSL.

No hexavalent chromium was detected in the duplicate sample.

4.12.2 Deviations from Final Zone H RFI Work Plan

Twelve soil samples were proposed to be collected in the Final Zone H RFI Work Plan. The actual number of soil samples collected at AOC 654 was 11 (six upper interval, five lower interval). All proposed upper interval samples were collected. Due to shallow depth to groundwater, only five of the second interval samples were collected from the proposed locations.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.12.1
AOC 654
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(11 Samples Collected — 6 Upper Interval Samples, 5 Lower Interval Samples, 1 Sample Duplicated)***			
Acetone	4/4	52-4,000/85-1,700	780,000
Carbon disulfide	0/1	0/11	780,000
Ethylbenzene	1/0	4.5/0	780,000
Methylene chloride	1/2	25/34-36	85,000
Toluene	5/3	2.8-10/8-17	160,000
Xylene (total)	1/0	44.7/0	16,000,000
Semivolatile Organic Compounds ***(11 Samples Collected — 6 Upper Interval Samples, 5 Lower Interval Samples, 1 Sample Duplicated)***			
Anthracene	0/1	0/130	2,300,000
Benzo(a)anthracene	0/1	0/140	880
Benzo(b)fluoranthene	1/0	110/0	880
bis(2-Ethylhexyl)phthalate (BEHP)	1/0	124/0	46,000
Chrysene	0/1	0/140	88,000
Fluoranthene	2/1	110-110/780	310,000
Pyrene	0/1	0/490	230,000
Pesticides ***(11 Samples Collected — 6 Upper Interval Samples, 5 Lower Interval Samples, 1 Sample Duplicated)***			
delta-BHC	1/0	1.2/0	350
4,4'-DDE	1/0	6.15/0	1,900
4,4'-DDT	1/0	10/0	1,900
alpha-Chlordane	1/0	69.1/0	alpha+gamma 470
gamma-Chlordane	1/0	40.85/0	
Endrin	1/0	2.0/0	2,300
Heptachlor	1/0	1.1/0	140
Heptachlor epoxide	1/0	4.1/0	70

Table 4.12.1
AOC 654
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Levels
Polychlorinated Biphenyls *(11 Samples Collected — 6 Upper Interval Samples, 5 Lower Interval Samples, 1 Sample Duplicated)*			
No PCBs detected.			
Total Petroleum Hydrocarbons *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No TPH (IR) detected.			
Herbicides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No herbicides detected.			
Organophosphate Pesticides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No organophosphates detected.			
Dioxins *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
Total TEQ	1/0	0.717/0 pg/g	1,000 pg/g

Table 4.12.2
AOC 654
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	6/5	6/5	2,830-6,890/3,510-6,530	7,900	25,310/46,180
Iron[a]	6/5	6/5	3,050-6,050/3,740-8,960	Not Listed	30,910/66,170
Lead	6/5	1/0	32.7/0	400	118/68.69
Nickel	6/5	6/5	2.4-17.9/13-30	160	33.38/29.9
Potassium[a]	6/5	6/5	189-1,140/830-1,520	Not Listed	Nutrient[c]
Silver	6/5	0/0	0/0	39	Not Valid[d]
Sodium[a]	6/5	6/5	129-3,570/1,230-4,010	Not Listed	Nutrient[c]
Thallium	6/5	0/0	0/0	0.63	0.63/1.3
Antimony	6/5	0/0	0/0	3.1	Not Valid[d]

Table 4.12.2
AOC 654
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Arsenic	6/5	6/5	2.2-7.7/4.4-18.4	0.37	14.81/35.52
Barium	6/5	4/0	11.8-38.7/0	550	40.33/43.88
Beryllium	6/5	6/5	0.17-0.49/0.29-0.59	0.15	1.466/1.62
Cadmium	6/5	2/4	0.56-0.97/0.24-1.5	3.9	1.05/1.10
Cobalt	6/5	6/5	0.48-3.1/0.54-4.3	470	5.863/14.88
Copper	6/5	6/5	1.6-57.1/6.7-13.1	290	27.6/31.62
Vanadium	6/5	6/5	7.4-29.4/18.2-37.1	55	77.38/131.6
Zinc	6/5	6/5	13-81.8/36.5-66.4	2,300	214.3/129.6
Selenium	6/5	2/2	1.2-2.6/2.4-3.0	39	2.0/2.7
Mercury	6/5	3/0	0.11-0.23/0	2.3	0.485/.74
Magnesium[a]	6/5	6/5	496-7,720/4,760-10,400	Not Listed	9,592/9,179
Manganese[a]	6/5	6/5	19.1-57.2/22.6-50.9	39	636.4/1,412
Calcium	6/5	6/5	15,000-219,000/175,000-265,000	Not Listed	Nutrient[e]
Chromium	6/5	6/5	11-53.3/36.1-70.7	39	85.65/83.86
Tin[a]	1/0	0/0	0/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	1/0	0/0	0/0	39	Not Valid[d]
Cyanide	6/5	1/1	2.0/1.0	160	Not Valid[d]

Notes:
(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTL.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

4.13 AOC 655

AOC 655 is the site where approximately 300 gallons of No. 2 fuel oil spilled in 1985 when a fuel line in the Building 656 boiler room ruptured. The line supplied fuel oil to the boiler from a nearby 5,800-gallon UST, which is also within the subject AOC. Approximately 150 gallons of the spilled fuel was reported to have escaped through a seam in the building's concrete floor to underlying soil.

A previous soil-gas investigation (Appendix L) near Building 656 identified responses for acetone, benzene, toluene, ethylbenzene, and oil compounds. Air sampling within Building 656 detected anthropogenic compounds, but did not identify the source.

Soil and groundwater were sampled at AOC 655 to assess any residual contamination from the previous oil spill and other releases which may have occurred in the vicinity. Sample locations are shown on Figure 4.13.1. Tables 4.13.1 and 4.13.2 summarize the organic and inorganic results, respectively, for soil. A complete analytical report for the soil samples collected at AOC 655 is in Appendix I.

4.13.1 Soil Sampling and Analysis

Soil sampling was conducted in two phases at AOC 655. During the primary soil sampling event, 12 soil samples were collected from eight locations. Eight soil samples were collected from the 0- to 1-foot depth interval, and four samples were collected from the 3- to 5-foot depth interval. Primary soil sample locations were based on the reported fuel oil spill, the UST and its associated piping, and the results of the previous soil-gas investigation conducted at the site. The locations were sampled using hand augers as described in Section 2.2.2. Two proposed soil sample locations in the boiler room were not sampled due to concrete overlying soil and the unknown location of utilities that were built into the concrete. Soil samples were analyzed for VOCs, SVOCs, metals, cyanide, pesticides/PCBs, and TPH. Eight samples were collected from five additional locations during the secondary sampling event. Five from the upper interval and three from the lower interval were analyzed for TPH and pesticides/PCBs. These additional sample locations were based on primary soil sample analytical results. Two samples selected for duplicate analysis as a QA measure were analyzed for hexavalent chromium, herbicides, organophosphate pesticides, and dioxins in addition to the standard suite of analyses.

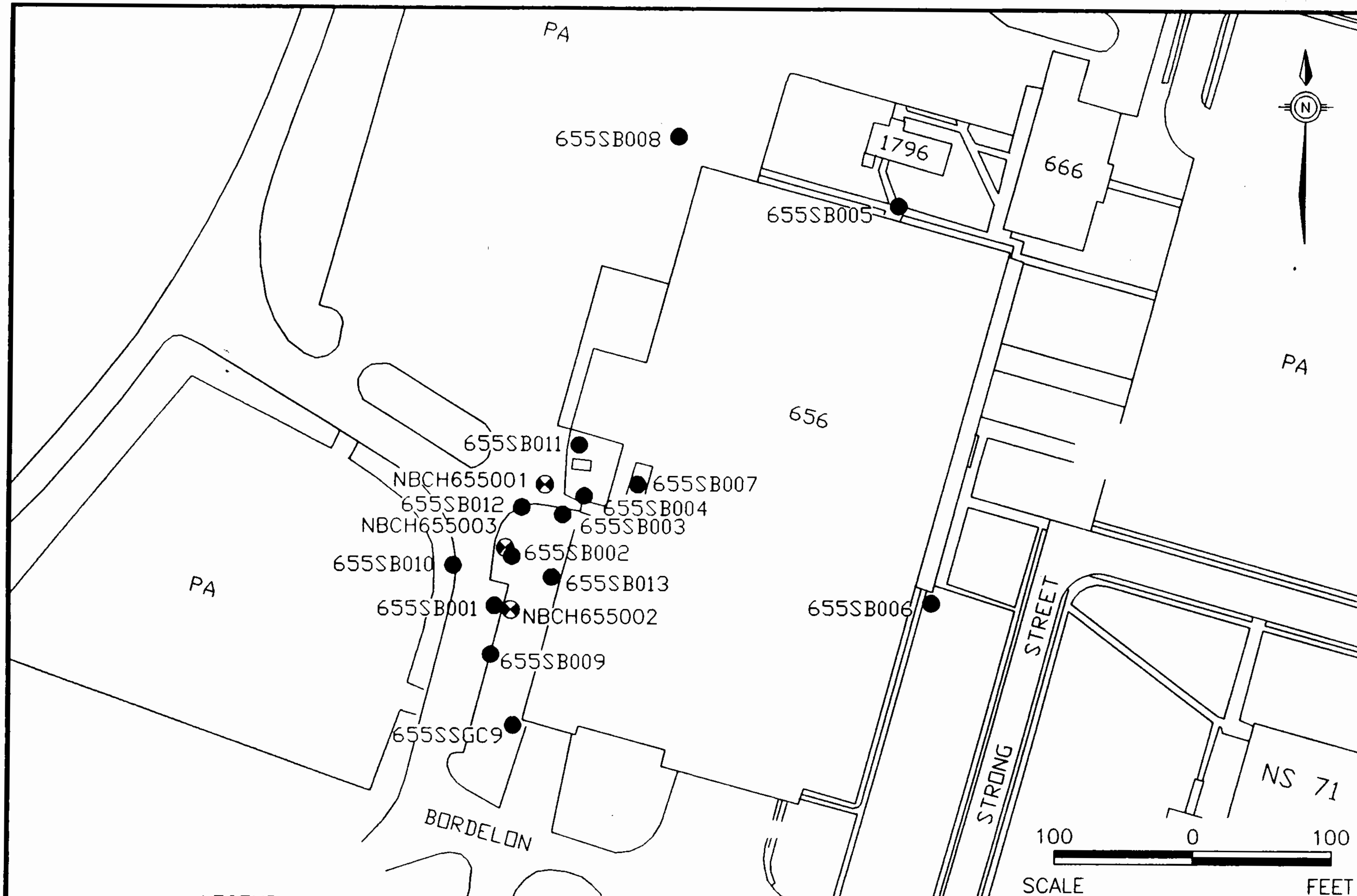
Results of a soil-gas confirmation sample (SGCSB009), next to Building 656, are included in the AOC 655 tables.

4.13.1.1 Volatile Organic Compounds in Soil

Five VOCs (acetone, 2-butanone, methylene chloride, tetrachloroethene, and toluene) were detected in one or more of the soil samples collected at AOC 655. Acetone and methylene chloride were detected in all samples analyzed for these compounds. Detected concentrations were two to four orders of magnitude less than each compound's RBSL. Toluene was detected in five upper interval and one lower interval samples at concentrations five orders of magnitude less than its RBSL. Tetrachloroethene and 2-butanone were each detected in one sample at a concentration of three and five orders of magnitude less than their respective RBSLs.

4.13.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected in three of the 13 samples analyzed for these compounds at AOC 655. Sixteen SVOCs were detected in the soil-gas confirmation sample (SGCSB009). Eight SVOCs were detected in a soil sample collected from the 0- to 1-foot interval at location 655SB005. One SVOC was detected in a soil sample from the 0- to 1-foot interval at location 655SB006. The following were present in soil samples collected at AOC 655 (including the soil-gas confirmation sample) at concentrations exceeding their respective RBSLs: benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. All above-RBSL detections were in the soil-gas confirmation sample.



LEGEND

- ● – SOIL SAMPLE LOCATION
- ⊗ – GROUNDWATER SAMPLE LOCATION

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.13.1
AOC 655
SOIL & GROUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 06/17/96 | DWG NAME: 29CFZH13

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4.13.1.3 Pesticides and PCBs in Soil

Pesticide compounds were present in soil samples from seven of the eight primary locations and in all five secondary sampling locations. Pesticides were detected in 12 of the 13 samples collected from the 0- to 1-foot interval and in four of seven samples collected from the 3- to 5-foot depth interval. Ten pesticide compounds were detected in the soil samples collected at AOC 655. Two of the compounds (aldrin and dieldrin) were detected at concentrations exceeding their RBSLs. Dieldrin (RBSL-40 μg/kg) was detected in a soil sample collected from the 0- to 1-foot interval at location 655SB007 (360 μg/kg) and in a sample collected from the 3- to 5-foot interval at location 655SB005 (61.8 μg/kg [average of original and duplicate sample results]). Aldrin (RBSL-38 μg/kg) was detected in the soil sample collected from the 3- to 5-foot interval at the same location (105 μg/kg [average of original and duplicate sample results]).

PCBs were detected at six of the eight primary sampling locations and at all five secondary locations. PCBs were detected in 13 of the 20 soil samples collected (11 of 13 samples in the upper interval and two of seven in the lower interval). Two PCB compounds (Aroclors-1254 and 1260) were detected in the soil samples collected at AOC 655. Detected concentrations of Aroclor-1260 exceeded the RBSL at sample locations 01, 02, 09, 011, and 012. The highest concentrations (610 and 750 μg/kg) were in the samples from the upper and lower intervals at location 655SB001. Detected concentrations of Aroclor-1254 also exceed its RBSL of 83 μg/kg at sample locations 655SB004 and 655SB005. The highest concentrations of Aroclor-1254 were detected in soil samples collected from the 0- to 1-foot and 3- to 5-foot intervals at location 655SB004 110 μg/kg and 180 μg/kg, respectively.

4.13.1.4 Other Organic Compounds in Soil

Petroleum hydrocrabons were detected at 10 of the 12 sample locations and in 12 of the 19 samples analyzed. Concentrations ranged from 11,000 μg/kg to 120,000 μg/kg. Indeterminate lubricating oil was the primary petroleum hydrocarbon detected at AOC 655.

Herbicides and organophosphate pesticides were not detected in the two duplicate samples collected.

Dioxin analysis was conducted on two duplicate samples collected at AOC 655. Total TEQs for dioxin (screening level 1,000 pg/g) were 0.818 pg/g and 1.299 pg/g for these two samples.

4.13.1.5 Inorganic Elements in Soil

Table 4.13.2 summarizes inorganic results from the AOC 655 soil samples. No inorganic elements were detected at concentrations exceeding both their respective RBSLs and UTLs for background.

Cyanide (RBSL-160 μg/kg) was detected in one soil sample from AOC 655; it was from the 0- to 1-foot interval at location 655SB001 at a concentration of 1.5 μg/kg, which is two orders of magnitude below the RBSL.

4.13.2 Groundwater Sampling and Analysis

Three shallow monitoring wells were installed to sample groundwater near AOC 655 (see Figure 4.13.1). Groundwater sampling was conducted in accordance with procedures detailed in Section 2.4. First-round groundwater samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. Based on results from these samples, second-round samples were analyzed for SVOCs, metals, and pesticides. One second-round sample was duplicated and analyzed for the same parameters as the primary samples. Tables 4.13.3 and 4.13.4 summarize organics and inorganics results respectively for groundwater. A complete report of analytical data for groundwater samples collected at AOC 655 is included in Appendix I.

4.13.2.1 Volatile Organic Compounds in Groundwater

No VOCs were reported for groundwater samples collected during the first sampling round from AOC 655. VOCs were not analyzed in second-round samples because they were not detected in first-round samples.

4.13.2.2 Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in the first-round or second-round groundwater samples from AOC 655.

4.13.2.3 Pesticides and PCBs in Groundwater

Two pesticide compounds were detected in the first and second round samples at AOC 655. Alpha-Chlordane and gamma-Chlordane were detected in well NBCH655002 at concentrations of 0.04 μg/L and 0.06 μg/L, respectively, during first-round sampling.. These concentrations, when combined, exceed the RBSL of 0.052 μg/L for Chlordane. During second-round sampling, the sample from well NBCH655002 reported alpha-Chlordane and gamma-Chlordane concentrations of 0.03 μg/L and 0.04 μg/L, respectively. These concentrations, when combined, are also above its RBSL.

No PCBs were detected in the groundwater samples collected at AOC 655.

4.13.2.4 Other Organic Compounds in Groundwater

No petroleum hydrocarbons were detected in the groundwater samples collected at AOC 655.

4.13.2.5 Inorganic Elements in Groundwater

Table 4.13.4 summarizes analytical results for inorganic chemicals from AOC 655 groundwater samples. Ten metals were detected at least once in samples from round one, while 12 metals were reported from second-round samples. Elements detected at concentrations above their corresponding RBSLs in first and second-round samples are arsenic (RBSL-0.038 μg/L) and manganese (RBSL-18 μg/L). One arsenic value from a first-round sample exceeded its UTL of 27.99 μg/L as well as its RBSL. All other detections were below UTLs.

First-round samples from wells NBCH655002 and NBCH655003 had arsenic concentrations of 22.9 μg/L and 42.3 μg/L, respectively. Manganese was detected in groundwater samples from wells NBCH655001, NBCH655002, and NBCH655003 at concentrations of 578 μg/L, 298 μg/L, and 437 μg/L, respectively.

Second-round groundwater samples from wells NBCH655002 and NBCH655003 reported arsenic concentrations of 10.6 μg/L and 27.9 μg/L, respectively. Manganese was detected at concentrations of 689 μg/L, 346 μg/L, and 416 μg/L for NBCH655001 through NBCH655003, respectively.

No cyanide was detected in the groundwater samples collected at AOC 655.

4.13.3 Deviations from Final Zone H RFI Work Plan

Eighteen soil samples were proposed for collection in the Final Zone H RFI Work Plan. The actual number of soil samples collected at AOC 655 was 21 (14 upper interval, seven lower interval). All proposed upper interval samples were collected. Due to shallow depth to groundwater, only some second-interval samples were collected from the proposed locations. Based on analytical data for soil samples collected during the initial phase of sampling, additional sample locations were identified. Both sampling intervals were attempted at each of these additional sample locations. As with the initial phase of sampling, a portion of the second interval samples at the additional sample locations were not collected due to shallow depth to groundwater.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.13.1
AOC 655
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(12 Samples Collected — 8 Upper Interval Samples, 4 Lower Interval Samples, 2 Samples Duplicated)***			
Acetone	9/4	17-4,400/72-180	780,000
2-Butanone (MEK)	1/0	19/0	4,700,000
Methylene chloride	7/4	10-34/10-29	85,000
Tetrachloroethene	0/1	0/4.4	12,000
Toluene	6/1	2.9-8/5	1,600,000
Semivolatile Organic Compounds ***(12 Samples Collected — 8 Upper Interval Samples, 4 Lower Interval Samples, 2 Samples Duplicated)***			
Acenaphthene	1/0	140/0	470,000
Acenaphthylene	1/0	440/0	470,000
Anthracene	1/0	1,800/0	2,300,000
Benzo(a)anthracene	2/0	91-3,300/0	880
Benzo(b)fluoranthene	1/0	120-2,100/0	880
Benzo(k)fluoranthene	1/0	1,800/0	8,800
Benzo(g,h,i)perylene	1/0	960/0	310,000
Benzo(a)pyrene	1/0	2,400/0	88
BEHP	2/0	150-1,800/0	46,000
Butylbenzylphthalate	1/0	98/0	1,600,000
Chrysene	2/0	100-2,700/0	8,000
Dibenzo(a,h)anthracene	1/0	520/0	88
Dibenzofuran	1/0	210/0	31,000
Fluoranthene	2/0	170-4,200/0	310,000
Fluorene	1/0	660/0	310,000
Indeno(1,2,3-cd)pyrene	1/0	1,100	880
Phenanthrene	2/0	98.0-4,200/0	310,000
Pyrene	2/0	160-5,300/0	230,000

Table 4.13.1
AOC 655
Organic Compounds in Soil (µg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Levels
Pesticides *(20 Samples Collected — 13 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
Aldrin	0/1	0/96	38
4,4'-DDE	6/1	2.6-13/6.4	1,900
4,4'-DDT	4/2	4-23/7-25	1,900
alpha-Chlordane	9/2	4-97/3-9	alpha+gamma 470
gamma-Chlordane	9/3	4-130/3.6-22	
Dieldrin	4/1	2.4-360/52.9	40
Endosulfan II	1/0	4.0/0	47,000
Endrin aldehyde	2/1	8-16/29	2,300
Heptachlor	2/0	1.3-11/0	140
Heptachlor epoxide	5/0	2-24/0	70
Polychlorinated Biphenyls *(20 Samples Collected — 13 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
Aroclor-1254	3/1	81-110/180	83
Aroclor-1260	8/1	25.8-610/750	83
Total Petroleum Hydrocarbons *(19 Samples Collected — 12 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
TPH	9/3	14,000-120,000/ 15,000-120,000	Not Listed
Herbicides *(2 Duplicate Analyses — 1 Upper Interval Sample, 1 Lower Interval Sample)*			
No herbicides detected.			
Organophosphate Pesticides *(2 Duplicate Analyses — 1 Upper Interval Sample, 1 Lower Interval Sample)*			
No organophosphates detected.			
Dioxins *(2 Duplicate Analyses — 1 Upper Interval Sample, 1 Lower Interval Sample)*			
Total TEQ	1/1	1.299/0.818 pg/g	1000 pg/g

Table 4.13.2
AOC 655
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	8/4	9/4	2,500-15,300/2,720-6,640	7,900	25,310/46,180
Iron[a]	8/4	9/4	2,060-21,200/1,540-5,650	Not Listed	30,910/66,170
Lead	9/4	5/0	3.2-215/0	400	118/68.69
Nickel	9/4	9/4	1.2-12.7/1.1-2.0	160	33.38/29.9
Potassium[a]	8/4	8/4	117-167/82.4-235	Not Listed	Nutrient[e]
Silver	9/4	0/0	0/0	39	Not Valid[d]
Sodium[a]	8/4	9/4	50.7-1,270/33.2-210	Not Listed	Nutrient[e]
Thallium	9/4	0/0	0/0	0.63	0.63/1.3
Antimony	9/4	0/0	0/0	3.1	Not Valid[d]
Arsenic	9/4	9/4	1.4-12.7/0.84-2.8	0.37	14.81/35.52
Barium	9/4	8/4	3.4-23.2/4.0-19.9	550	40.33/43.80
Beryllium	9/4	9/4	0.09-0.91/0.06-0.21	0.15	1.466/1.62
Cadmium	9/4	6/0	0.24-0.56/0	3.9	1.05/1.10
Cobalt	9/4	9/4	0.6-5.2/0.74-1.0	470	5.863/14.88
Copper	9/4	9/4	1.4-41.6/0.37-1.1	290	27.6/31.62
Vanadium	9/4	9/4	4.8-43.2/3.9-9.95	55	77.38/131.6
Zinc	9/4	9/4	13.6-115/4.4-7.7	2,300	214.3/129.6
Selenium	9/4	0/1	0/0.51	39	2.0/2.7
Mercury	9/4	8/1	0.02-0.11/2.0	2.3	0.485/0.74
Magnesium[a]	9/4	8/4	276-5,710/177-520	Not Listed	9,592/9,179
Manganese[a]	9/4	8/4	13.7-382/8.2-40.3	39	636.4/1,412
Calcium	9/4	8/4	1,560-152,000/2,550-5,930	Not Listed	Nutrient[e]
Chromium	10/4	8/4	5.3-35.8/3.9-9.2	39	85.65/83.86
Tin[a]	1/1	0/0	0/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	1/1	0/0	0/0	39	Not Valid[d]
Cyanide	8/4	1/0	1.5/0	160	Not Valid[d]

Notes:

(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTL.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.13.3
AOC 655
Organic Compounds in Groundwater (μg/L)

Round 1: 3 Samples Collected, 0 Samples Duplicated
Round 2: 3 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Maximum Contaminant Level
Volatile Organic Compounds (Collected in Round 1 Only)					
No VOCs detected.					
Semivolatile Organic Compounds (Collected in Rounds 1 and 2)					
No SVOCs detected.					
Pesticides (Collected in Rounds 1 and 2)					
alpha-Chlordane	1	1	0.04	0.052	2
	2	1	0.03	(alpha+gamma)	(alpha+gamma)
gamma-Chlordane	1	1	0.06	0.052	2
	2	1	0.04	(alpha+gamma)	(alpha+gamma)
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Collected in Round 1 Only)					
No TPH detected.					

Table 4.13.4
AOC 655
Inorganic Chemicals in Groundwater (μg/L)

Round 1: 3 Samples Collected, 0 Samples Duplicated
Round 2: 3 Samples Collected, 1 Sample Duplicated

Chemical Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[(b)]	Max. Contam. Level
Aluminum[(c)]	1	2	1,040-1,750	3,700	Not Valid	Not Listed
	2	3	26.60-2,210			
Arsenic	1	2	22.9-42.3	0.038	27.99	50
	2	2	10.6-27.9			
Barium	1	3	54.7-255	260	323	2,000
	2	3	46.5-211			
Calcium[(c)]	1	3	153,000-196,000	Not Listed	Nutrient	Not Listed
	2	3	161,500-271,000			
Chromium[(d)]	1	0	--	18[(e)]	Not Valid	100
	2	2	3.5-4.0			
Iron	1	3	17,600-45,400	Not Listed	45,760	Not Listed
	2	3	16,750-39,300			
Magnesium	1	3	175,000-541,000	Not Listed	3,866,000	Not Listed
	2	3	122,000-649,000			
Manganese	1	3	298-578	18	3,391	Not Listed
	2	3	346-689			
Potassium[(c)]	1	3	52,200-161,000	Not Listed	Nutrient	Not Listed
	2	3	16,900-90,350			
Sodium[(c)]	1	3	1,780,000-3,940,000	Not Listed	Nutrient	Not Listed
	2	3	1,240,000-4,570,000			
Vanadium[(d)]	1	1	10.1	26	Not Valid	Not Listed
	2	3	4.0-10.1			
Zinc	1	0	--	1,100	Not Valid	Not Listed
	2	1	7.7			
Cyanide[(a)]	1	--	Not Detected			
	2	--	No Analysis			

Notes:
(a) = Only elements with detections are listed. Cyanide was a separate analysis.
(b) = See Appendix J for UTL determinations.
(c) = Element considered to be a nutrient; therefore, UTL was not determined.
(d) = High percentage of nondetects in background samples prevented determination of UTL.
(e) = If trivalent chromium, RBSL-3700 μg/L.
(f) = Based on treatment technique AL.

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4.14 AOC 659

AOC 659 is the site of a 30,000-gallon steel AST, that stored diesel fuel from 1958 to 1990. The tank, between Hobson and Dyess Avenues, is surrounded by a 5-foot-high earthen berm.

Soil was sampled at AOC 659 to evaluate whether contamination is associated with the AST. As per the Final Zone H RFI Work Plan, the scope did not include groundwater sampling.

4.14.1 Soil Sampling and Analysis

Soil was sampled in a single phase from locations shown on Figure 4.14.1 in accordance with Section 2.2. Tables 4.14.1 and 4.14.2 summarize organic and inorganic results, respectively, for soil. Appendix I presents a complete analytical report for the samples collected at AOC 659.

Eight soil samples were collected from four locations — four from the 0- to 1-foot depth interval and four from the 3- to 5-foot depth interval. Sampling locations were selected inside the four corners of the containment berm, in areas most likely to have been impacted if a release occurred. Samples were analyzed for VOCs, SVOCs, cyanide, metals, TPH, and pesticides/PCBs. One sample selected for duplicate analysis was analyzed for hexavalent chromium, herbicides, organophosphate pesticides, and dioxins in addition to the standard suite of analyses listed above.

4.14.1.1 Volatile Organic Compounds in Soil

VOCs were detected at each of the four sample locations and in five of the eight samples analyzed. Of the five samples in which VOCs were detected, one was from the 0- to 1-foot depth interval and four were from the 3- to 5-foot depth interval. Four VOCs (acetone, methylene chloride, ethylbenzene, and toluene) were detected in the soil samples collected at AOC 659. VOC concentrations ranged from two to four orders of magnitude less than their respective RBSLs.

4.14.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected at each of the four sampling locations and in six of the eight samples analyzed. Of the six samples in which SVOCs were detected, four samples were from the 0- to 1-foot depth interval and two were from the 3- to 5-foot depth interval. Twelve different SVOCs were detected in the AOC 659 soil samples. None of the SVOCs were detected at concentrations exceeding their respective RBSL. The detected SVOC concentrations ranged from one to four orders of magnitude below respective RBSLs.

4.14.1.3 Pesticides and PCBs in Soil

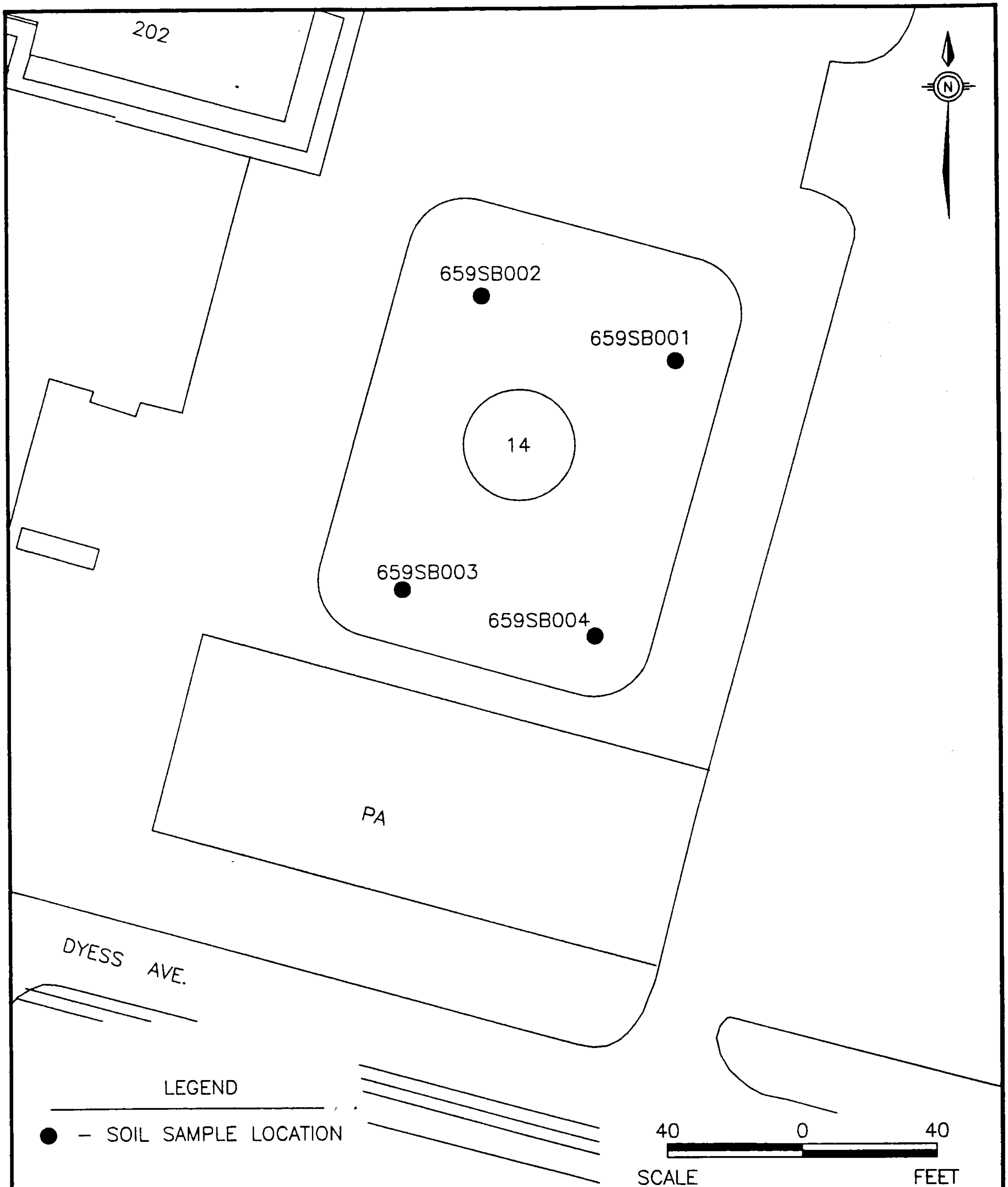
Seven pesticides were detected in three of the four sampling locations and in four of the seven samples analyzed. Of the four detections, two were from the 0- to 1-foot depth interval and two were from the 3- to 5-foot depth interval. Pesticide concentrations ranged from one to four orders of magnitude below respective RBSLs.

PCBs were not detected in the soil samples collected at AOC 659.

4.14.1.4 Other Organic Compounds in Soil

TPH analysis identified petroleum hydrocarbons at all four sample locations and in six of the eight samples analyzed. Of the six TPH detections, three were from the 0- to 1-foot depth interval and three samples were collected from the 3- to 5-foot interval. TPH concentrations ranged from 77,000 to 15,000,000 μg/kg.

Organophosphate pesticides were not detected in the duplicate soil sample collected at AOC 659. Herbicides were detected in the duplicate sample (659CB001). Two herbicide compounds (2,4,5-TP [Silvex], and 2,4,5-T) were detected in the 0- to 1-foot interval at concentrations approximately four orders of magnitude below respective RBSLs.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.14.1
AOC 659
SOIL SAMPLE LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH02

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Dioxins were detected in the sample submitted for duplicate analysis. Total TEQ for the sample were 0.738 pg/g (screening level 1,000 pg/g).

4.14.1.5 Inorganic Elements in Soil

Table 4.14.2 summarizes inorganic element results from the soil samples collected at AOC 659. No elements have detections exceeding both their respective RBSLs and interval-specific UTLs for background.

Cyanide and hexavalent chromium were not detected in soil samples collected from AOC 659.

4.14.3 Deviations from Final Zone H RFI Work Plan

All soil samples that were proposed in the Final Zone H RFI Work Plan were collected.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.14.1
AOC 659
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st Interval/2nd Interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)***			
Acetone	1/2	8.75/45.6-71.1	780,000
Ethylbenzene	0/2	0/3.59-2,660	780,000
Methylene chloride	0/2	0/264-328	85,000
Toluene	1/1	1.5/395	1,600,000
Semivolatile Organic Compounds ***(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)***			
Acenaphthene	0/1	0/49.4	470,000
Dibenzofuran	0/4	0/44.9-3,510	31,000
Di-n-butylphthalate	1/0	52/0	780,000
Benzo(a)anthracene	0/1	0/70.5	880
Benzo(b)fluoranthene	0/1	0/73.6	880
Chrysene	1/0	82/0	88,000
Fluoranthene	0/2	0/94.5-345	310,000
bis(2-Ethylhexyl)phthalate (BEHP)	2/0	106-423/0	46,000
2-Methylnaphthalene	0/3	0/1,740-11,100	310,000
Naphthalene	0/3	0/490-5,150	310,000
Phenanthrene	0/4	0/58.8-3,210	310,000
Pyrene	0/2	0/375-428	230,000
Pesticides ***(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)***			
4,4'-DDD	0/2	0/28.4-50.2	2,700
4,4'-DDE	0/2	0/18.3-103	1,900
4,4'-DDT	1/0	3.6/0	1,900
alpha-Chlordane	1/0	1.3/0	470 alpha + gamma
gamma-Chlordane	2/0	3.8-10/0	
Dieldrin	1/0	2.7/0	40
Endosulfan sulfate	1/0	2.4/0	47,000

Table 4.14.1
AOC 659
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st Interval/2nd Interval)	Risk-Based Screening Levels
Polychlorinated Biphenyls *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
No PCBs detected.			
Total Petroleum Hydrocarbons *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
Total Petroleum Hydrocarbons	3/3	77,000-190,000/ 2,200,000-15,000,000	Not Listed
Herbicides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
2,4,5-TP (Silvex)	1/0	9.1/0	63,000
2,4,5-T	1/0	9.0/0	78,000
Organophosphate Pesticides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No organophosphates detected.			
Dioxins *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
Total TEQs	1/0	0.738/0 pg/g	1,000 pg/g

Table 4.14.2
AOC 659
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	4/4	4/4	2,310-6,870/1,540-3,560	7,900	25,310/46,180
Iron[a]	4/4	4/4	1,610-4,290/2,510-4,030	Not Listed	30,910/66,170
Lead	4/4	4/4	2.4-12.1/2.2-3.5	400	118/68.69
Nickel	4/4	1/0	0.77/0	160	33.38/29.9
Potassium[a]	4/4	0/0	0/0	Not Listed	Nutrient[e]
Silver	4/4	0/0	0/0	39	Not Valid[d]
Sodium[a]	4/4	3/4	16.40-271/22.7-63.1	Not Listed	Nutrient[e]
Thallium	4/4	0/0	0/0	0.63	0.63/1.3
Antimony	4/4	0/0	0/0	3.1	Not Valid[d]
Arsenic	4/4	4/4	0.61-2.3/1.2-1.9	0.37	14.81/35.52
Barium	4/4	2/2	6.4-8.6/4.5-11.1	550	40.33/43.80
Beryllium	4/4	2/4	0.16-0.21/0.05-0.2	0.15	1.466/1.62
Cadmium	4/4	1/0	0.22/0	3.9	1.05/1.10
Cobalt	4/4	2/3	1.0-1.0/0.64-1.3	470	5.863/14.88
Copper	4/4	0/0	0/0	290	27.6/31.62
Vanadium	4/4	4/4	4.15-16.6/5.1-8.3	55	77.38/131.6
Zinc	4/4	2/0	15.2-30.7/0	2,300	214.3/129.6
Selenium	4/4	0/0	0/0	39	2.0/2.7
Mercury	4/4	1/0	0.08/0	2.3	0.485/0.74
Magnesium[a]	4/4	4/4	36.9-1,820/128-582	Not Listed	9,592/9,179
Manganese[a]	4/4	4/4	4.5-38.7/9.3-34.4	39	636.4/1,412
Calcium	4/4	4/4	550-58,600/1,130-2,750	Not Listed	Nutrient[e]
Chromium	4/4	3/4	4.2-18.4/4.3-6.6	39	85.65/83.86
Tin[a]	1/0	1/0	1.5/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	1/0	0/0	0/0	39	Not Valid[d]
Cyanide	4/4	0/0	0/0	160	Not Valid[d]

Notes:
(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTL.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

4.15 AOC 660

In the 1950s, AOC 660 was used to mix and rinse pesticides associated with mosquito control. This area is currently an asphalt parking lot immediately west of Building NS-53.

Soil and groundwater were sampled at AOC 660 to determine if contamination resulted from pesticide handling or other releases onsite.

4.15.1 Soil Sampling and Analysis

Soil was sampled in a single phase at AOC 660 at the eight locations shown on Figure 4.15.1 and in accordance with Section 2.2. Tables 4.15.1 and 4.15.2 summarize organic and inorganic results, respectively, for soil. Appendix I presents a complete analytical report for samples collected at AOC 660.

During sampling, 10 soil samples were collected from eight sampling locations. Eight samples were collected from the 0- to 1-foot depth interval and two from the 3- to 5-foot depth interval where the former building was identified on historic maps. Samples were analyzed for VOCs, SVOCs, cyanide, metals, TPH, and pesticides/PCBs. One sample selected for duplicate analysis was also analyzed for hexavalent chromium, herbicides, organophosphate pesticide, and dioxins in addition to the standard suite of analyses.

4.15.1.1 Volatile Organic Compounds in Soil

VOCs were detected in six of the eight sampling locations, and in six of all 10 samples analyzed. Of the six samples in which VOCs were detected, five samples were from the 0- to 1-foot depth interval and one sample was collected from the 3- to 5-foot depth interval. Three VOCs (acetone, toluene, and 2-butanone) were detected in the soil samples from AOC 660. VOC concentrations ranged from four to six orders of magnitude below their respective RBSLs.

4.15.1.2 Semivolatile Organic Compounds in Soil

SVOCs were not detected in the soil samples collected from AOC 660.

4.15.1.3 Pesticides and PCBs in Soil

Eight pesticides were detected in all eight sampling locations, and nine of all 10 samples analyzed. Of the nine pesticide detections, eight were from the 0- to 1-foot depth interval and one sample was from the 3-to 5-foot interval. Except for toxaphene, all pesticide detections ranged from two to three orders of magnitude below their respective RBSLs. Toxaphene (RBSL-800 μg/kg) was detected at a concentration of 100 μg/kg in the first interval of 660SB002.

PCBs were not detected in the soil samples collected from AOC 660.

4.15.1.4 Other Organic Compounds in Soil

No petroleum hydrocarbons or organophosphate pesticides were detected in the one duplicate soil sample collected from AOC 660.

A herbicide was detected in the duplicate sample (660CB005) collected from the 0- to 1-foot interval. Silvex (RBSL-63000 μg/kg) was detected in the sample at a concentration four orders of magnitude below its RBSL. No other herbicides were detected in the duplicate sample analysis.

Dioxins were detected in the sample submitted for duplicate analysis (660CB005). Total TEQ for the sample were 2.611 pg/g (screening level 1,000 pg/g).

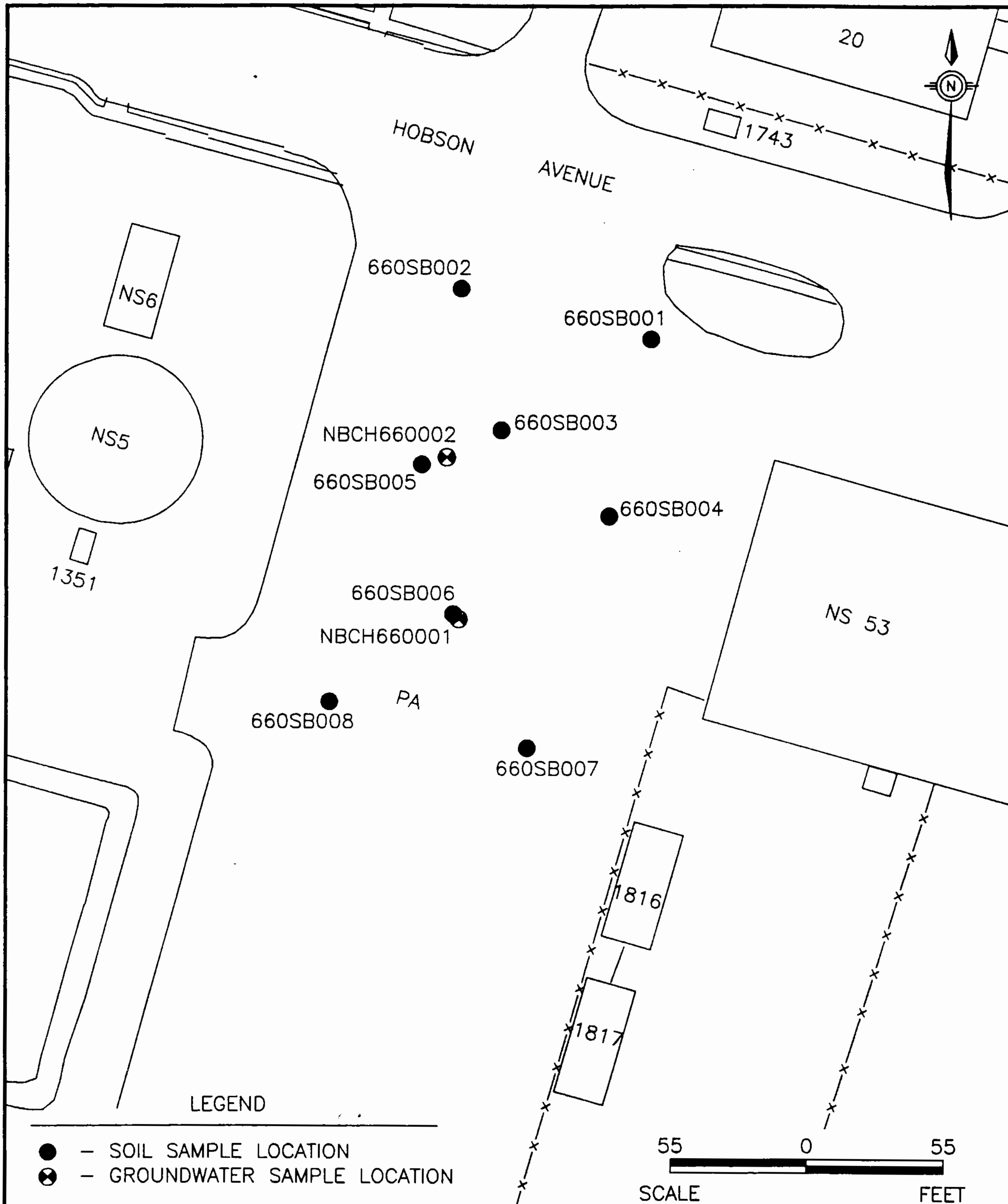

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FIGURE 4.15.1
AOC 660
SOIL & GROUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH03

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4.15.1.5 Inorganic Elements in Soil

Table 4.15.2 summarizes the inorganic elements result from the soil samples collected at AOC 660. No elements were detected at concentrations exceeding both their respective RBSLs and interval-specific UTLs for background.

Cyanide and hexavalent chromium were not detected in the soil samples collected at AOC 660.

4.15.2 Groundwater Sampling and Analysis

Two monitoring wells were installed to sample shallow groundwater near AOC 660 (see Figure 4.15.1) in accordance with the procedures outlined in Section 2.4. First-round samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. Based on results from the first round, second-round samples were analyzed for metals and pesticides. One second-round sample was duplicated and analyzed for the same parameters as the primary samples. Tables 4.15.3 and 4.15.4 summarize organic and inorganic results, respectively, for groundwater. Appendix I contains a complete report of the analytical data for groundwater samples collected from AOC 660.

4.15.2.1 Volatile Organic Compounds in Groundwater

No VOCs were detected in the groundwater samples collected at AOC 660.

4.15.2.2 Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in the groundwater samples collected at AOC 660.

4.15.2.3 Pesticides and PCBs in Groundwater

Pesticides and PCBs were not detected in the groundwater samples collected at AOC 660.

4.15.2.4 Other Organic Compounds in Groundwater

Petroleum hydrocarbons were not detected in the groundwater samples collected at AOC 660.

4.15.2.5 Inorganic Elements in Groundwater

Table 4.15.4 summarizes inorganic results from the AOC 660 groundwater samples. Of the 13 metals detected, only manganese and arsenic were found at concentrations exceeding their corresponding RBSLs. None of the metals concentrations in groundwater samples was above its corresponding UTL.

First-round samples from wells NBCH660001 and NBCH660002 reported manganese (RBSL-18 μg/L) concentrations of 49.6 μg/L and 73.6 μg/L, respectively. Second-round samples from wells NBCH660001 and NBCH660002 had concentrations of 62.1 μg/L and 108.5 μg/L, respectively. Arsenic (RBSL-0.038 μg/L) was detected only in a second-round sample from well NBCH660002 at a concentration of 12.8 μg/L.

Cyanide was not detected in the groundwater samples collected at AOC 660.

4.15.3 Deviations from Final Zone H RFI Work Plan

Sixteen soil samples were proposed for collection in the Final Zone H RFI Work Plan. The actual number of soil samples collected at AOC 660 was 10 (eight upper interval, two lower interval). All proposed upper interval samples were collected. Due to shallow depth to groundwater, only two of the lower interval samples were collected from the proposed locations.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.15.1
AOC 660
Organic Compounds in Soil (in μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st Interval/2nd Interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(10 Samples Collected — 8 Upper Interval Samples, 2 Lower Interval Samples, 1 Samnle Duplicated)***			
Acetone	2/0	23-73.7	780,000
2-Butanone (MEK)	1/1	4.1/12	4,700,000
Toluene	3/1	3.5-9/6	160,000
Semivolatile Organic Compounds ***(10 Samples Collected — 8 Upper Interval Samples, 2 Lower Interval Samples, 1 Sample Duplicated)***			
No SVOCs detected.			
Pesticides ***(10 Samples Collected — 8 Upper Interval Samples, 2 Lower Interval Samples, 1 Sample Duplicated)***			
4,4'-DDD	5/0	5-12	2,700
4,4'-DDE	8/1	3-62/2	1,900
4,4'-DDT	3/0	4-12	1,900
alpha-Chlordane	1/0	4	470 (alpha+gamma)
gamma-Chlordane	2/0	4-4	
Endrin aldehyde	1/0	7	2,300
Heptachlor	1/0	4	140
Toxaphene	1/0	100	800
Polychlorinated Biphenyls ***(10 Samples Collected — 8 Upper Interval Samples, 2 Lower Interval Samples, 1 Sample Duplicated)***			
No PCBs detected.			
Total Petroleum Hydrocarbons ***(1 Duplicate Analysis — 1 Upper Interval Sample)***			
No TPH detected.			
Herbicides ***(1 Duplicate Analysis — 1 Upper Interval Sample)***			
2,4,5-TP (Silvex)	1/0	8.6	63,000
Organophosphate Pesticides ***(1 Duplicate Analysis — 1 Upper Interval Sample)***			
No organophosphates detected.			
Dioxins ***(1 Duplicate Analysis — 1 Upper Interval Sample)***			
Total TEQ	1/0	2.611/0 pg/g	1,000 pg/g

Table 4.15.2
AOC 660
Inorganic Elements in Soil (in mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	8/2	8/2	2,290-9,559/955-3,070	7,900	25,310/46,180
Iron[a]	8/2	8/2	452-2,530/1,440-4,500	Not Listed	30,910/66,170
Lead	8/2	4/0	2.2-27.0/0	400	118/68.69
Nickel	8/2	3/0	0.86-1.4/0	160	33.38/29.9
Potassium[a]	8/2	0/0	0/0	Not Listed	Nutrient[e]
Silver	8/2	0/0	0/0	39	Not Valid[d]
Sodium[a]	8/2	4/0	108-298/0	Not Listed	Nutrient[e]
Thallium	8/2	1/0	0.35/0	0.63	0.63/1.3
Antimony	8/2	0/0	0/0	3.1	Not Valid[d]
Arsenic	8/2	4/0	0.41-1.6/0	0.37	14.81/35.52
Barium	8/2	3/0	4.1-20/0	550	40.33/43.80
Beryllium	8/2	4/0	0.08-0.45/0	0.15	1.466/1.62
Cadmium	8/2	0/0	0/0	3.9	1.05/1.10
Cobalt	8/2	4/0	0.42-4.9/0	470	5.863/14.88
Copper	8/2	8/2	0.49-4.4/0.31-1.3	290	27.6/31.62
Vanadium	8/2	4/0	3.7-11.4/0	55	77.38/131.6
Zinc	8/2	0/0	0/0	2,300	214.3/129.6
Selenium	8/2	1/0	0.4/0	39	2.0/2.7
Mercury	8/2	4/0	0.02-0.12/0	2.3	0.485/0.74
Magnesium[a]	8/2	4/2	105-663/254-837	Not Listed	9,592/9,179
Manganese[a]	8/2	4/0	8.4-73/0	39	636.4/1,412
Calcium	8/2	7/2	3,450-118,000/3,160-6,830	Not Listed	Nutrient[e]
Chromium	8/2	4/0	3.3-9.6/0	39	85.65/83.86
Tin[a]	1/0	1/0	2.9/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	1/0	0/0	0/0	39	Not Valid[d]
Cyanide	8/2	0/0	0/0	160	Not Valid[d]

Notes:
[a] = Elements that are not included in both SW-846 and Appendix IX methods.
[b] = Included in duplicate sample analyses only.
[c] = See Appendix J for UTL determination.
[d] = Number of nondetections prevented determination of UTL.
[e] = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.15.3
AOC 660
Organic Compounds in Groundwater (μg/L)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds (Collected in Round 1 Only)					
No VOCs detected.					
Semivolatile Organic Compounds (Collected in Round 1 Only)					
No SVOCs detected.					
Pesticides (Collected in Rounds 1 and 2)					
No pesticides detected					
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Collected in Round 1 Only)					
No TPH detected.					

Table 4.15.4
AOC 660
Inorganic Chemicals in Groundwater (μg/L)[a]

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 1 Sample Duplicated

Chemical Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[c]	1	2	18.3-25.8	3,700	Not Valid	Not Listed
	2	1	1,940			
Arsenic	1	0	--	0.038	27.99	50
	2	1	12.8			
Barium	1	2	1.9-8.3	260	323	2,000
	2	2	4.70-17.9			
Calcium[d]	1	2	60,900-122,000	Not Listed	Nutrient	Not Listed
	2	2	55,700-133,000			
Chromium[c]	1	0	--	18[e]	Not Valid	100
	2	1	2.75			
Iron	1	2	625-1,800	Not Listed	45,760	Not Listed
	2	2	556-5695			
Magnesium	1	2	23,900-31,300	Not Listed	3,866,000	Not Listed
	2	2	23,800-28,600			
Manganese	1	2	49.6-73.6	18	3,391	Not Listed
	2	2	62.1-108.5			
Potassium[d]	1	2	21,200-22,600	Not Listed	Nutrient	Not Listed
	2	2	18,250-19,300			
Silver[c]	1	1	3.5	18	Not Valid	Not Listed
	2	0	--			
Sodium[d]	1	2	51,300-91,500	Not Listed	Nutrient	Not Listed
	2	2	44,950-66,500			
Vanadium[c]	1	0	--	26	Not Valid	Not Listed
	2	2	2.6-7.6			
Zinc[c]	1	0	--	1,100	Not Valid	Not Listed
	2	1	8.6			
Cyanide[c]	1	--	Not Detected			
	2	--	No Analysis			

Notes:
(a) = Only elements with detections are listed. Cyanide was a separate analysis.
(b) = See Appendix J for UTL determinations.
(c) = High percentage of nondetects in background samples prevented determination of UTL.
(d) = Element considered to be a nutrient; therefore, UTL was not determined.
(e) = If trivalent chromium, RBSL-3700 μg/L.

4.16 AOC 662

AOC 662 is a former gasoline service station and possibly a billeting office. The site was used as a service station for an unknown duration beginning in 1958. The site was subsequently converted and is currently a nonhazardous material storage area. Two unregistered steel USTs may remain onsite.

Soil and groundwater were sampled at AOC 662 to determine if contamination resulted from gasoline storage and dispensing from the USTs or other releases onsite.

4.16.1 Soil Sampling and Analysis

Soil was sampled in a single phase at locations shown on Figure 4.16.1 in accordance with the procedures outlined in Section 2.2. Tables 4.16.1 and 4.16.2 summarize organic and inorganic results, respectively, for soil. Appendix I presents a complete analytical report for AOC 662 samples.

Eight soil samples were collected from four sampling locations; four samples were collected from the 0- to 1-foot depth interval and four from the 3- to 5-foot depth interval. Samples were collected from each corner of the tank pad to detect possible contamination from any unreported releases associated with the service station. Samples were analyzed for VOCs, SVOCs, cyanide, metals, TPH, and pesticides/PCBs. One sample selected as a duplicate was analyzed for hexavalent chromium, herbicides, organophosphate pesticide, and dioxins in addition to the standard suite of analyses.

4.16.1.1 Volatile Organic Compounds in Soil

Acetone was detected in all four sampling locations, and in five of the eight samples analyzed. Of the five VOC detections, two were from the 0- to 1-foot depth interval and three samples were from the 3- to 5-foot interval. Acetone concentrations were five orders of magnitude below its RBSL.

4.16.1.2 Semivolatile Organic Compounds in Soil

Two SVOCs were detected in one of the eight samples analyzed. SVOCs were detected in the 0- to 1-foot interval of sample location 662SB002 at four orders of magnitude below their respective RBSLs.

4.16.1.3 Pesticides and PCBs in Soil

Two pesticides (4,4'-DDE and 4,4'-DDT) were detected in all four sampling locations, and in five of the eight samples analyzed. Of the five pesticide detections, two were from the 0- to 1-foot depth interval and three samples were from the 3- to 5-foot depth interval. Pesticide concentrations ranged from two to three orders of magnitude below their respective RBSLs.

PCBs were not detected in the soil samples collected from AOC 662.

4.16.1.4 Other Organic Compounds in Soil

Petroleum hydrocarbons were not detected in any of the soil samples collected from AOC 662.

Organophosphate pesticides, and herbicides were not detected in the duplicate sample collected from AOC 662.

Dioxin was detected in the sample submitted for duplicate analysis (662CB002). The TEQ for the sample was 0.662 pg/g (screening level 1,000 pg/g).

4.16.1.5 Inorganic Elements in Soil

Table 4.16.2 summarizes the inorganic element results from the soil samples collected at AOC 662. No elements were detected at concentrations exceeding both their respective RBSLs and interval-specific UTLs for background.

Cyanide or hexavalent chromium were not detected in the soil samples collected at AOC 662.

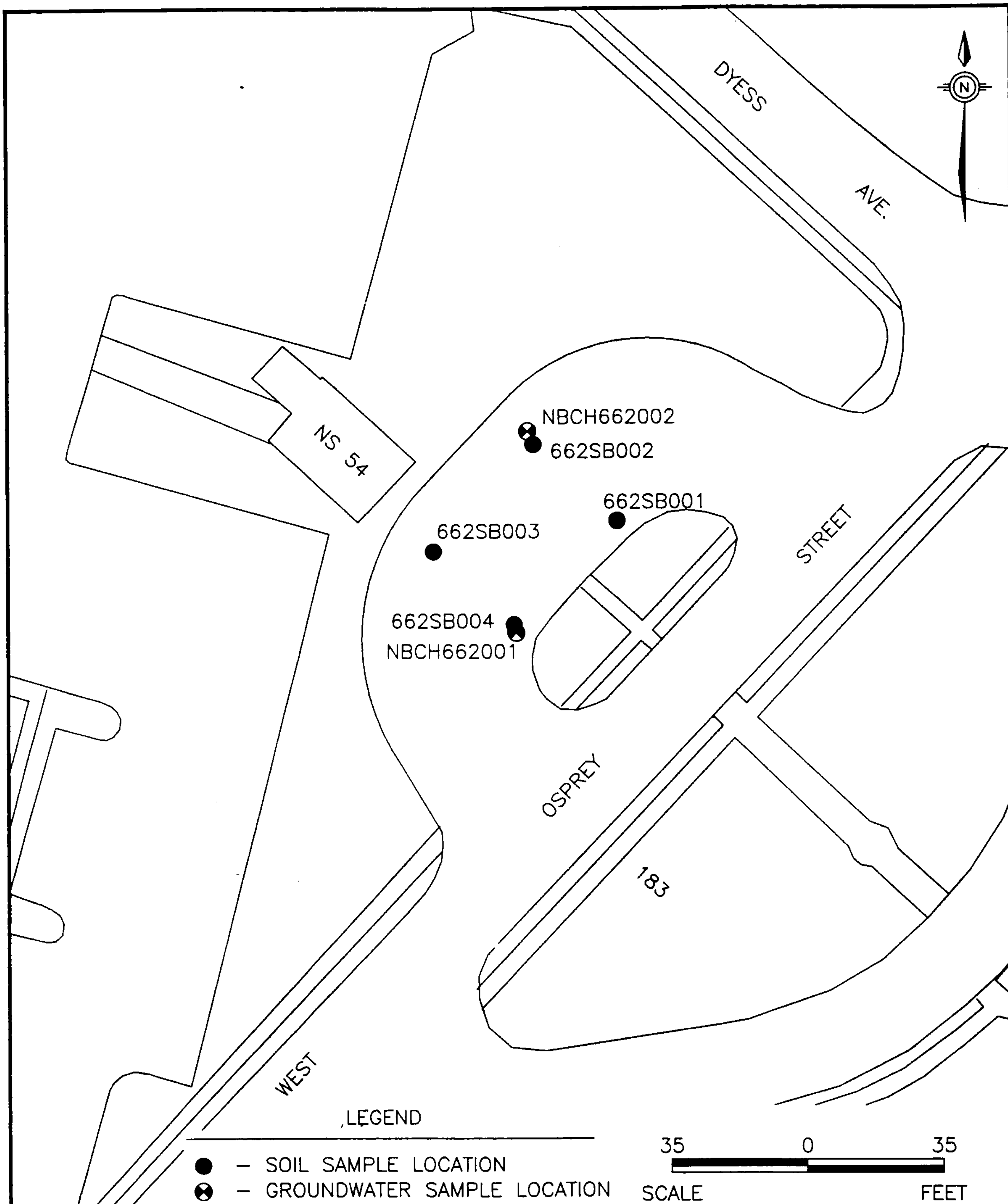

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FIGURE 4.16.1
AOC 662
SOIL & GROUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH07

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4.16.2 Groundwater Sampling and Analysis

Two monitoring wells were installed to sample groundwater at AOC 662 (Figure 4.16.1). Groundwater was sampled in accordance with the procedures outlined in Section 2.4 and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH during first-round groundwater sampling. Based on the analytical results from the first round, second-round samples were analyzed for VOCs, SVOCs, and metals. Tables 4.16.3 and 4.16.4 summarize organic and inorganic results, respectively, for groundwater. Appendix I presents a complete report of the analytical data for groundwater samples collected at AOC 662.

4.16.2.1 Volatile Organic Compounds in Groundwater

No VOCs were detected in the groundwater samples collected at AOC 662 during the first or second sampling rounds.

4.16.2.2 Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in the groundwater samples collected at AOC 662.

4.16.2.3 Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in the groundwater samples collected at AOC 662.

4.16.2.4 Other Organic Compounds in Groundwater

No petroleum hydrocarbons were detected in the groundwater samples collected at AOC 662.

4.16.2.5 Inorganic Elements in Groundwater

Table 4.16.4 summarizes the inorganic results from AOC 662 groundwater samples. Only manganese exceeded its RBSL (18 μg/L). First-round samples from monitoring wells NBCH662001 and NBCH662002 reported manganese concentrations of 434 μg/L and 402 μg/L, respectively; second-round concentrations were 629 μg/L and 379 μg/L, respectively. All manganese values were below the UTL of 3,391 μg/L.

Cyanide was not detected in the groundwater samples collected at AOC 662.

4.16.3 Deviations from Final Zone H RFI Work Plan

All soil and groundwater samples were collected.

Table 4.0.3 lists the quantities of proposed samples and actual samples collected.

Table 4.16.1
AOC 662
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
Acetone	2/3	27-33/25-79	780,000
Semivolatile Organic Compounds *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
Fluoranthene	1/0	63.1	310,000
Pyrene	1/0	85.4	230,000
Pesticides *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
4,4'-DDE	2/3	2.65-4/4-6	1,900
4,4'-DDT	1/0	3.7	1,900
Polychlorinated Biphenyls *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
No PCBs detected.			
Total Petroleum Hydrocarbons *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
No TPH detected.			
Herbicides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No herbicides detected.			
Organophosphate Pesticides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No organophosphates detected.			
Dioxins *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
Total TEQ	1/0	0.662/0 pg/g	1000 pg/g

Table 4.16.2
AOC 662
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	4/4	4/4	2,130-3,450/2,700-4,330	7,900	25,310/46,180
Iron[a]	4/4	4/4	3,060-4,240/3,780-5,490	Not Listed	30,910/66,170
Lead	4/4	4/3	3.9-4.3/4.2-6.2	400	118/68.69
Nickel	4/4	4/4	6.5-8.0/6.4-12.1	160	33.38/29.9
Potassium[a]	4/4	4/4	243-343/240-437	Not Listed	Nutrient[e]
Silver	4/4	0/0	0/0	39	Not Valid[d]
Sodium[a]	4/4	4/4	961-1,070/651-1,020	Not Listed	Nutrient[e]
Thallium	4/4	0/0	0/0	0.63	0.63/1.3
Antimony	4/4	1/0	2.2/0	3.1	Not Valid[d]
Arsenic	4/4	4/4	5.65-6.8/5.5-7.8	0.37	14.81/35.52
Barium	4/4	4/3	19.7-23.9/8.3-24.7	550	40.33/43.80
Beryllium	4/4	4/2	0.58-0.74/0.6-0.68	0.15	1.466/1.62
Cadmium	4/4	4/2	0.2-0.33/0.27-0.39	3.9	1.05/1.10
Cobalt	4/4	4/3	2.0-12.9/2.4-22.1	470	5.863/14.88
Copper	4/4	4/3	1.8-3.05/2.0-2.7	290	27.6/31.62
Vanadium	4/4	4/4	14.3-17.1/12.7-18.6	55	77.38/131.6
Zinc	4/4	4/4	13.7-15.3/12.6-38.9	2,300	214.3/129.6
Selenium	4/4	3/4	0.31-0.96/0.67-1.5	39	2.0/2.7
Mercury	4/4	1/0	0.02/0	2.3	0.485/0.74
Magnesium[a]	4/4	4/4	533-729/474-5,810	Not Listed	9,592/9,179
Manganese[a]	4/4	4/4	38.8-58.6/43.6-88.9	39	636.4/1,412
Calcium	4/4	4/4	49,800-56,300/47,000-168,000	Not Listed	Nutrient[e]
Chromium	4/4	4/4	18.5-20.8/17.3-31.7	39	85.65/83.86
Tin[a]	1/0	0/0	0/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	1/0	0/0	0/0	39	Not Valid[d]
Cyanide	4/4	0/0	0/0	160	Not Valid[d]

Notes:

(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Section Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UL.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.16.3
AOC 662
Organic Compounds in Groundwater ($\mu g/L$)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 0 Samples Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds (Collected in Rounds 1 and 2)					
No VOCs detected.					
Semivolatile Organic Compounds (Collected in Rounds 1 and 2)					
No SVOCs detected.					
Pesticides (Collected in Round 1 Only)					
No pesticides detected.					
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Collected in Round 1 Only)					
No TPH detected.					

Table 4.16.4
AOC 662
Inorganic Elements in Groundwater (μg/L)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 0 Samples Duplicated

Compound Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Barium	1	2	7.1-29.6	260	323	2,000
	2	2	10.7-24.7			
Calcium[c]	1	2	137,000-160,000	Not Listed	Nutrient	Not Listed
	2	2	110,000-123,000			
Iron	1	2	798-2,770	Not Listed	45,760	Not Listed
	2	2	1,560-1,980			
Lead	1	1	1.1	15[e]	4.697	15[e]
	2	0	--			
Magnesium	1	2	45,600-66,600	Not Listed	3,866,000	Not Listed
	2	2	36,100-94,000			
Manganese	1	2	402-434	18	3,391	Not Listed
	2	2	379-629			
Potassium[c]	1	2	21,800-30,700	Not Listed	Nutrient	Not Listed
	2	2	17,300-41,100			
Sodium[c]	1	2	301,000-374,000	Not Listed	Nutrient	Not Listed
	2	2	237,000-686,000			
Vanadium [d]	1	0	--	26	Not Valid	Not Listed
	2	1	3.2			
Cyanide[d]	1	--	Not Detected			
	2	--	No Analysis			

Notes:
(a) = Only elements with detections are listed. Cyanide was a separate analysis.
(b) = See Appendix J for UTL determinations.
(c) = Element considered to be a nutrient; therefore, UTL was not determined.
(d) = High percentage of nondetects in background samples prevented determination of UTL.
(e) = Based on treatment technique AL.

4.17 AOC 663 and SWMU 136

AOC 663 is a diesel pumping station at Building 851 with two 500-gallon USTs and five flammable-storage lockers. It has been active since 1983. The lockers along the west side of the station store hazardous material from adjacent buildings. SWMU 136 is an SAA that receives hazardous waste from Buildings 851 and NS-53.

Soil and groundwater were sampled at AOC 663 and SWMU 136 to determine if contamination resulted from diesel fuel storage and dispensing from the USTs or other releases at the sites.

4.17.1 Soil Sampling and Analysis

Soil was sampled in three phases at AOC 663 and SWMU 136 at the locations shown on Figure 4.17.1 in accordance with the procedures outlined in Section 2.2. Table 4.17.1 and 4.17.2 summarize organic and inorganic results, respectively, for soil. Appendix I presents a complete analytical report for samples collected at AOC 663 and SWMU 136..

During the first soil sampling event, seven soil samples were collected from five locations. Of the seven collected, five were from the 0- to 1-foot depth interval and two were from the 3- to 5-foot depth interval. Sampling locations were selected to combine sampling efforts related to both the SAA and active pumping station in areas most likely to have been impacted if a release occurred. Samples were analyzed for VOCs, SVOCs, cyanide, metals, TPH and pesticides/PCBs. One sample was duplicated and analyzed for hexavalent chromium, herbicides, organophosphate pesticides, and dioxins in addition to the standard suite of analyses.

During the second round of sampling, five soil samples were collected from four locations. Four samples were collected from the 0- to 1-foot depth interval and one was from the 3- to 5-foot depth interval. The additional sample locations were based on the analytical results from the primary round of soil samples. These samples were analyzed for SVOCs, metals, pesticides and PCBs.

One upper-interval sample collected during the third round of sampling was analyzed for SVOCs.

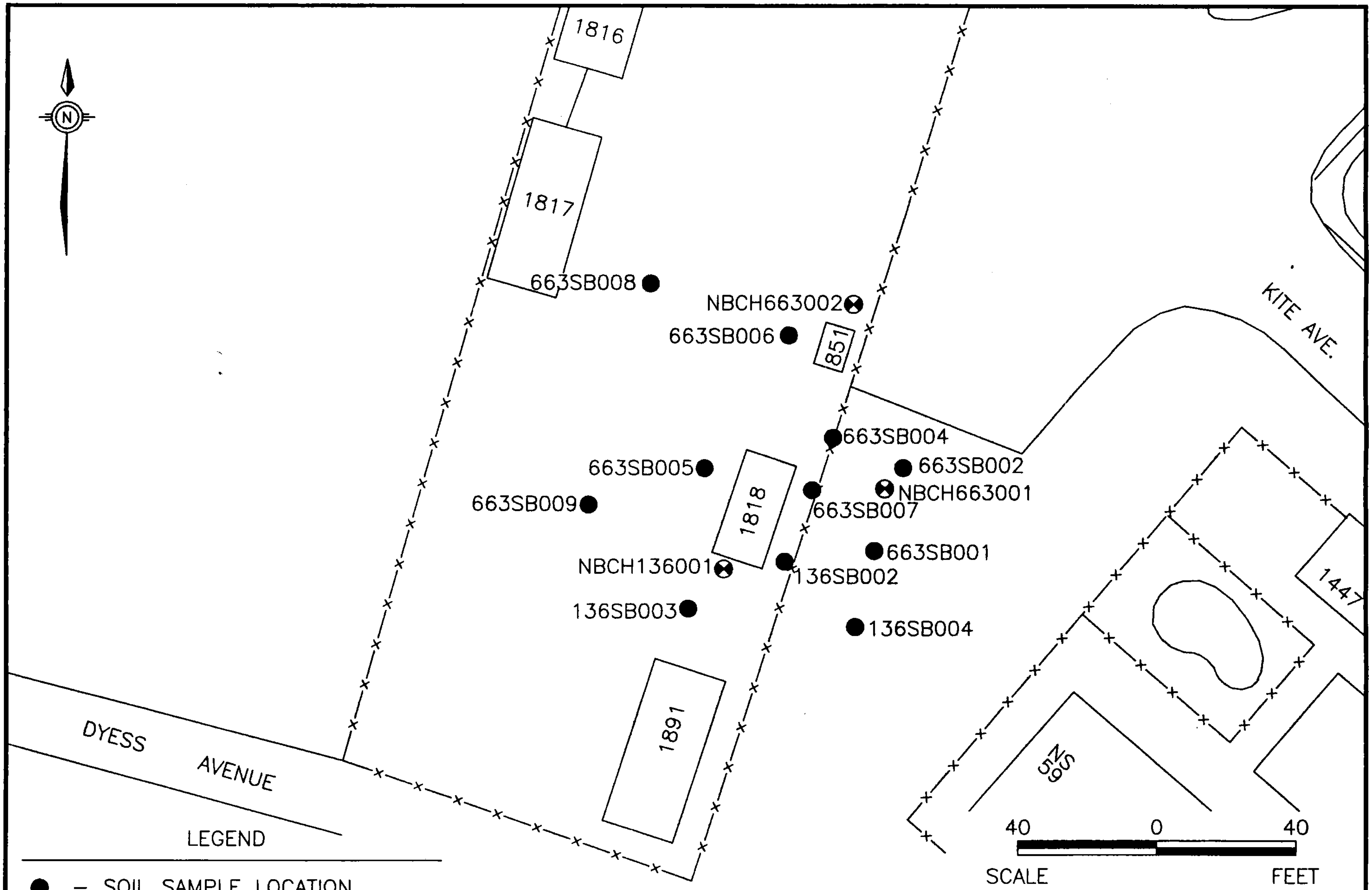
As at numerous locations within Zone H, a coring machine was employed to penetrate the asphalt cover to provide access to the first sampling interval. However, at AOC 663 concrete was encountered underlying the asphalt cover at the initial 663SB005, 663SB006, and 136SB003 boring locations. Penetration of this concrete was unsuccessfully attempted (6-8 inches) with the coring machine at these initial locations. During the second round of soil sampling the boring locations were adjusted to their present location as shown on Figure 4.17.1 of the Zone H RFI Report. The concrete was not present at these locations. The origin of the concrete at the above-listed original locations is not known. It is, perhaps, an old building foundation or concrete pad.

4.17.1.1 Volatile Organic Compounds in Soil

VOCs were detected in two of the five primary sampling locations and in three of the seven samples analyzed. Of the three samples in which VOCs were detected, one sample was collected from the 0- to 1-foot depth interval and two samples were collected from the 3- to 5-foot depth interval. VOC concentrations (acetone and methylene chloride) ranged from three to four orders of magnitude below their respective RBSLs.

4.17.1.2 Semivolatile Organic Compounds in Soil

Of the nine samples with SVOC detections, seven were from the 0- to 1-foot depth interval and two were from the 3- to 5-foot depth interval. Fifteen SVOCs were detected in the soil samples from AOC 663 and SWMU 136. Benzo(a)anthracene, benzo(b)fluoranthene, benzo[a]pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3)pyrene were detected at concentrations ranging from two orders of magnitude above their RBSLs (benzo(a)pyrene) to just greater than their RBSLs (indeno[1,2,3-cd]pyrene). Refer to Table 4.17.1 for details. The sample locations with the most



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.17.1
AOC 663 & SWMU 136
SOIL & GROUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH08

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detections exceeding the RBSLs were at 663SB007 and 136SB002. Concentrations decrease toward sample locations 663SB005 and 663SB002. The remaining compounds were detected at concentrations ranging from one to five orders of magnitude below respective RBSLs.

4.17.1.3 Pesticides and PCBs in Soil

Pesticides were detected in five of the seven primary soil sample locations, in three of the four secondary soil sample locations, and in eight of all 12 samples analyzed. Nine pesticides were detected. 4,4'-DDE and alpha- and gamma-chlordane were detected at concentrations above their respective RBSLs. 4,4'-DDE (RBSL=1,900 μg/kg) was detected at a concentration of 4,480 μg/kg in the first interval of 663SB004. The combined total of alpha- and gamma-chlordane (RBSL=470 μg/kg) was detected at a concentration of 812 μg/kg in the first interval of 663SB005.

PCBs were detected in one of the seven primary sample locations, and in none of the secondary soil samples. The PCB detection was in the 0- to 1-foot depth interval at sample location 136SB002. Aroclor-1254 (RBSL=83 μg/kg) was detected at 695 μg/kg in this sample. No other PCBs were detected in the soil samples at AOC 663 and SWMU 136.

4.17.1.4 Other Organic Compounds in Soil

TPH analysis identified petroleum hydrocarbons at all four sample locations and in four of the seven samples analyzed. TPH detections ranging from 73,000 to 190,000 μg/kg were in the 0- to 1-foot interval at sample locations 136SB002, 663SB002, 663SB004, and 663SB005.

Herbicides were detected in the duplicate sample (663CB002) collected from the 0- to 1-foot interval. Silvex (RBSL= 63,000 μg/kg) was detected at a concentration of 7.3 μg/kg. No other herbicides were detected in the duplicate sample analysis.

Organophosphate pesticides were not detected in the duplicate sample analysis.

Dioxins were detected in the sample submitted for duplicate analysis (663CB00201). Total TEQs for the sample were 4.93 pg/g (screening level 1,000 pg/g).

4.17.1.5 Inorganic Elements in Soil

Table 4.17.2 summarizes the inorganic element analytical results from the soil samples collected at AOC 663 and SWMU 136. Elements exceeding their respective RBSLs and interval-specific UTLs for background are aluminum, cadmium, manganese, vanadium, and arsenic. Aluminum (RBSL= 7,900 mg/kg; upper-interval UTL= 25,310 mg/kg) was detected at a concentration of 31,900 mg/kg in the first interval of sample location 136SB004. Cadmium (RBSL-3.9 mg/kg; upper-interval UTL= 1.05 mg/kg) was detected at 7.4 mg/kg in the first interval at soil sample location 136SB002. Manganese (RBSL-39 mg/kg; upper-interval UTL= 636.4 mg/kg) was detected at 826 mg/kg in the first interval at soil sample location 136SB004. Vanadium (RBSL-55 mg/kg; upper-interval UTL= 77.38 mg/kg) was detected at a concentration of 84.5 mg/kg in the first interval of sample location 136SB004. Arsenic (RBSL=0.37 mg/kg; upper-interval UTL= 14.81 mg/kg) was detected at a concentration of 16.2 and 23.9 mg/kg in the first interval of sample locations 663SB007 and 136SB004, respectively.

Cyanide was not detected in any of the soil samples at AOC 663 and SWMU 136.

Hexavalent chromium was not detected in the duplicate sample analysis.

4.17.2 Groundwater Sampling and Analysis

Three monitoring wells were installed to sample the groundwater near AOC 663 and SWMU 136 (See Figure 4.17.1). Groundwater samples were analyzed in accordance with Section 2.4 of this report. First-round samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. One duplicate sample was analyzed for hexavalent chromium, herbicides, organophosphate pesticides, and dioxins in addition to the standard suite of analyses. Based on first-round sample results, second-round samples were analyzed for VOCs, SVOCs, and metals.

Two of the second-round samples (from the AOC 663 wells) were also analyzed for herbicides. One of the samples was duplicated and submitted for analysis of the same parameters as the primary samples. Tables 4.17.3 and 4.17.4 summarize the organic and inorganic results, respectively, for groundwater. Appendix I presents a complete report of the analytical data for groundwater samples collected from AOC 663 and SWMU 136.

4.17.2.1 Volatile Organic Compounds in Groundwater

No VOCs were detected in first-round groundwater samples from AOC 663 and SWMU 136.

Four VOCs were detected during the second sampling round, all in the sample from well NBCH663002. The reported value of one of the four compounds exceeded its corresponding RBSL. Benzene (RBSL-0.346 μg/L) was detected at a concentration of 160 μg/L. Ethylbenzene (RBSL-130 μg/L), toluene (RBSL= 75 μg/L), and xylene (total) (RBSL= 1,200 μg/L) were detected at concentrations of 19, 37, and 26 μg/L, respectively.

4.17.2.2 Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in first-round groundwater samples from AOC 663 and SWMU 136.

Phenol (RBSL=2,200 μg/L) was the only SVOC detected in second-round samples. Its reported concentration of 7.2 μg/L in the sample from well NBCH663002 was far below its RBSL of 2,200 μg/L.

4.17.2.3 Pesticides and PCBs in Groundwater

Pesticides and PCBs were not detected in the groundwater samples collected at AOC 663 and SWMU 136.

4.17.2.4 Other Organic Compounds in Groundwater

Petroleum hydrocarbons and organophosphate pesticides were not detected in the groundwater samples collected at AOC 663 and SWMU 136.

The herbicide 2,4-dichlorophenoxybutyric acid (2,4-DB) was detected in the first-round duplicate sample from monitoring well NBCH663001 at a concentration of more than one order of magnitude below its RBSL of 29 μg/L for tap water. No other herbicides were detected in the duplicate sample, or in the two second-round samples analyzed for herbicides.

Dioxins were detected in the first-round sample submitted for duplicate analysis (NBCH663001). Total TEQs for the sample were 1.329 pg/L, which exceeds the RBSL of 0.5 pg/L for dioxins.

4.17.2.5 Inorganic Elements in Groundwater

Table 4.17.4 summarizes the analytical results for inorganics from the groundwater samples collected at AOC 663 and SWMU 136. Elements exceeding corresponding RBSLs are manganese and arsenic. Manganese (RBSL= 18 μg/L) was detected at concentrations of 548, 29.2, and 149 μg/L in first-round samples from NBCH663001, NBCH663002, and NBCH136001, respectively. In second-round samples, manganese was detected at concentrations of 539, 41.5, and 167 μg/L from wells NBCH663001, NBCH663002, and NBCH136001. Arsenic (RBSL= 0.038 μg/L) was detected in one first-round sample from NBCH663001 at 7.1 μg/L, and in one second-round sample from NBCH136001 at 12.2 μg/L.

None of the manganese or arsenic concentrations exceeded its corresponding UTL.

Cyanide and hexavalent chromium were not detected in the groundwater samples collected at AOC 663 and SWMU 136.

4.17.3 Deviations from Final Zone H RFI Work Plan

Twenty soil samples were proposed for collection in the Final Zone H RFI Work Plan. The actual number of soil samples collected at AOC 663 and SWMU 136 was 14 (10 upper interval, four lower interval). Due to shallow depth to groundwater and underlying concrete, samples were not collected from a portion of the original proposed locations during the first round of sampling. Based on analytical data for soil samples that were collected during the initial phase of sampling and failure to sample some of the locations due to concrete, a second attempt was made to sample the locations previously attempted. By making repeated attempts within the area of each sample location, five (four upper and one lower) additional samples were collected. Based on the results of these samples, two third-round sample locations were attempted. At one of these locations (663SB008) no sample was collected due to thick sections of concrete and asphalt. Both intervals were sampled at the other third-round sample location (663SB009). Depth to groundwater and underlying concrete prevented collection of the majority of the proposed lower-interval samples.

Groundwater samples were collected from each sample location proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.17.1
AOC 663 and SWMU 136
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds *(7 Samples Collected — 5 Upper Interval Samples, 2 Lower Interval Samples, 1 Sample Duplicated)*			
Acetone	0/2	0/32.1-46.4	780,000
Methylene Chloride	1/0	11.2/0	85,000
Semivolatile Organic Compounds *(14 Samples Collected — 10 Upper Interval Samples, 4 Lower Interval Samples, 2 Samples Duplicated)*			
Anthracene	3/0	43.9-2,200/0	2,300,000
Benzo(a)anthracene	5/0	69.8-1,400/0	880
Benzo(b)fluoranthene	5/1	168-6,300/57.5	880
Benzo(k)fluoranthene	1/0	212/0	8,800
Benzo(g,h,i)perylene	4/0	173-780/0	310,000
Benzo(a)pyrene	5/0	82.9-3,200/0	88
bis(2-Ethylhexyl)phthalate (BEHP)	4/2	61.9-904/117-159	46,000
Di-n-butylphthalate	1/2	40.9/44-45.2	780,000
Chrysene	5/0	82.1-3,500/0	88,000
Dibenzo(a,h)anthracene	3/0	49.3-350/0	88
Fluoranthene	8/2	48.8-1,970/51.7-210	310,000
Fluorene	1/0	160/0	310,000
Indeno(1,2,3-cd)pyrene	4/0	124-980/0	880
Phenanthrene	4/0	41.3-608/0	310,000
Pyrene	6/1	90-3,400/140	230,000
Pesticides *(12 Samples Collected — 9 Upper Interval Samples, 3 Lower Interval Samples, 1 Sample Duplicated)*			
delta-BHC	1/0	4.0/0	490
4,4'-DDD	5/0	14.9-1,940/0	2,700
4,4'-DDE	8/0	3-4,480/0	1,900
4,4'-DDT	6/0	12.8-1,390/0	1,900

Table 4.17.1
AOC 663 and SWMU 136
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Pesticides *(12 Samples Collected — 9 Upper Interval Samples, 3 Lower Interval Samples, 1 Sample Duplicated)*			
alpha-Chlordane	5/0	3-389/0	470 (alpha + gamma)
gamma-Chlordane	5/0	6-423/0	
Endosulfan I	1/0	10/0	47,000
Endrin	1/0	7.95/0	2,300
Heptachlor epoxide	3/0	3-31.1/0	70
Polychlorinated Biphenyls *(12 Samples Collected — 9 Upper Interval Samples, 3 Lower Interval Samples, 1 Sample Duplicated)*			
Aroclor-1254	1/0	695/0	83
Total Petroleum Hydrocarbons *(7 Samples Collected — 5 Upper Interval Samples, 2 Lower Interval Samples, 1 Sample Duplicated)*			
Total Petroleum Hydrocarbons (IR)	4/0	73,000-190,000/0	Not Listed
Herbicides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
Silvex	1/0	7.3/0	63,000
Organophosphate Pesticides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No organophosphates detected.			
Dioxins *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
Total TEQ	1/0	4.930/0 pg/g	1000 pg/g

Table 4.17.2
AOC 663 and SWMU 136
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c] (mg/kg)
Aluminum[a]	9/3	9/3	724-31,900/5,400-6,610	7,900	25,310/46,180
Iron[a]	9/3	9/3	4,030-37,700/6,520-11,300	Not Listed	30,910/66,170
Lead	9/3	7/3	22.6-118/3.5-16.5	400	118/68.69
Nickel	9/3	6/1	6.4-17.1/4.2	160	33.38/29.9
Potassium[a]	9/3	3/1	309-2,100/1,040	Not Listed	Nutrient[e]
Silver	9/3	0/0	0/0	39	Not Valid[d]
Sodium[a]	9/3	9/3	60.7-214/33.3-232	Not Listed	Nutrient[e]
Thallium	9/3	0/0	0/0	0.63	0.63/1.3
Antimony	9/3	0/0	0/0	3.1	Not Valid[d]
Arsenic	9/3	9/3	3.3-23.9/3.6-7.1	0.37	14.81/35.52
Barium	9/3	5/1	9.5-29.9/12.6	550	40.33/43.80
Beryllium	9/3	9/3	0.10-1.4/0.1-0.55	0.15	1.466/1.62
Cadmium	9/3	7/2	0.18-7.4/0.29-0.31	3.9	1.05/1.10
Cobalt	9/3	9/3	1.1-8.3/0.61-2.8	470	5.863/14.88
Copper	9/3	5/1	1.5-67.25/1.7	290	27.6/31.62
Vanadium	9/3	9/3	4.4-84.5/15.2-17.7	55	77.38/131.6
Zinc	9/3	7/2	48.4-816/28-40.8	2,300	214.3/129.6
Selenium	9/3	2/1	0.34-0.51/0.41	39	2.0/2.7
Mercury	9/3	4/0	0.03-0.19/0	2.3	0.485/0.74
Magnesium[a]	9/3	9/3	358-3,710/186-1,950	Not Listed	9,592/9,179
Manganese[a]	9/3	9/3	28.2-826/10.6-157	39	636.4/1,412
Calcium	9/3	9/3	3,200-411,000/804-629,000	Not Listed	Nutrient[e]
Chromium	9/3	9/3	8.1-54.3/9.1-14.3	39	85.65/83.86
Tin[a]	1/0	1/0	2.0/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	1/0	0/0	0/0	39	Not Valid[d]
Cyanide	5/2	0/0	0/0	160	Not Valid[d]

Notes:
[a] = Elements that are not included in both SW-846 and Appendix IX methods.
[b] = Included in duplicate sample analyses only.
[c] = See Appendix J for UTL determination.
[d] = Number of nondetections prevented determination of UTL.
[e] = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.17.3
AOC 663 and SWMU 136
Organic Compounds in Groundwater ($\mu g/L$)

Round 1: 3 Samples Collected, 1 Sample Duplicated
Round 2: 3 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds (Round 1: 3 Samples Collected, 1 Sample Duplicated) (Round 2: 3 Samples Collected, 1 Sample Duplicated)					
Benzene	1	0	--	0.346	5
	2	1	160		
Ethylbenzene	1	0	--	130	700
	2	1	19		
Toluene	1	0	--	75	1,000
	2	1	37		
Xylene (Total)	1	0	--	1,200	10,000
	2	1	26		
Semivolatile Organic Compounds (Round 1: 3 Samples Collected, 1 Sample Duplicated) (Round 2: 3 Samples Collected, 1 Sample Duplicated)					
Phenol	1	0	--	2,200	Not Listed
	2	1	7.2		
Pesticides (Round 1: 3 Samples Collected, 1 Sample Duplicated)					
No pesticides detected					
Polychlorinated Biphenyls (Round 1: 3 Samples Collected, 1 Sample Duplicated)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Round 1: 3 Samples Collected, 1 Sample Duplicated)					
No TPH detected.					
Herbicides (Round 1: 1 Sample Duplicated) (Round 2: 2 Samples Collected)					
2,4-DB	1	1	1.6	29	Not Listed
	2	0	--		
Organophosphate Pesticides (Round 1: 1 Sample Duplicated)					
No organophosphates detected.					
Dioxins (Round 1: 1 Sample Duplicated)					
Total TEQs	1	1	1.329 pg/L	0.5 pg/L	30pg/L
	2	--	No Analysis		

Table 4.17.4
AOC 663 and SWMU 136
Inorganic Chemicals in Groundwater ($\mu g/L$)

Round 1: 3 Samples Collected, 1 Sample Duplicated
Round 2: 3 Samples Collected, 1 Sample Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[c]	1 2	1 2	984 17.9-1700	3,700	Not Valid	Not Listed
Arsenic	1 2	1 1	7.1 12.2	0.038	27.99	50
Barium	1 2	2 3	4.3-21.5 2.5-19.3	260	323	2,000
Calcium[d]	1 2	3 3	51,700-131,000 42,800-109,000	Not Listed	Nutrient	Not Listed
Iron	1 2	3 3	1,530-8,500 2,970-7,130	Not Listed	45,760	Not Listed
Magnesium	1 2	3 3	9,270-63,100 11,400-61,550	Not Listed	3,866,000	Not Listed
Manganese	1 2	3 3	29.2-548 41.5-539	18	3,391	Not Listed
Potassium[d]	1 2	3 3	11,600-41,400 11,700-37,750	Not Listed	Nutrient	Not Listed
Sodium[d]	1 2	3 3	83,100-577,000 131,000-517,000	Not Listed	Nutrient	Not Listed
Vanadium[c]	1 2	0 1	-- 7	26	Not Valid	Not Listed
Zinc[c]	1 2	0 1	-- 10.6	1,100	Not Valid	Not Listed
Cyanide[c]	1 2	-- --	Not Detected No Analysis			
Hexavalent Chromium[c]	1 2	-- --	Not Detected No Analysis			

Notes:
(a) = Only elements with detections are listed. Hexavalent chromium and cyanide were separate analyses.
(b) = See Appendix J for UTL determinations.
(c) = High percentage of nondetects in background samples prevented determination of UTL.
(d) = Element considered to be a nutrient; therefore, UTL was not determined.

4.18 AOC 665

AOC 665 stored unknown pyrotechnics from 1943 until the shed was demolished at an unknown date. Currently, Buildings 1889 and NS-46 are on the site where the pyrotechnic shed was located.

Soil was sampled at AOC 665 to determine if residual contamination was associated with the former storage facility.

4.18.1 Soil Sampling and Analysis

Soil was sampled in a single phase at AOC 665 at locations shown on Figure 4.18.1 in accordance with the procedures outlined in Section 2.2. Tables 4.18.1 and 4.18.2 summarize organic and inorganic results, respectively, for soil. Appendix I presents a complete analytical report for the samples collected at AOC 665.

Four soil samples each were collected from the 0- to 1-foot interval and the 3- to 5-foot interval at four locations. These locations were on each side of Building 1889 in areas most likely to have been impacted if a release had occurred. Samples were analyzed for VOCs, SVOCs, cyanide, metals, TPH, and pesticides/PCBs. One sample selected as a duplicate was also analyzed for hexavalent chromium, herbicides, organophosphate pesticides, and dioxins in addition to the standard suite of analyses.

4.18.1.1 Volatile Organic Compounds in Soil

VOCs (acetone and toluene) were detected in all four sampling locations at AOC 665 and in six of the eight samples analyzed. Of the six VOC detections, three were from the 0-to 1-foot depth interval and three were from the 3- to 5-foot depth interval. VOC concentrations of acetone and toluene ranged from three to five orders of magnitude below their respective RBSLs.

4.18.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected at three of the four sampling locations at AOC 665 and in four of the eight samples analyzed. Ten SVOCs were detected. Of the four SVOC detections, three samples were from the 0-to 1-foot depth interval and one sample was from the 3- to 5-foot depth interval. Benzo(a)pyrene (RBSL= 88 μg/kg) was detected at 120 μg/kg in the first interval of sample location 665SB002. Except for benzo(a)anthracene and benzo(b)flouranthene which had detections of 170 and 120 μg/kg compared to RBSLs of 880 μg/kg, the remaining detections were one to three orders of magnitude below their respective RBSLs.

4.18.1.3 Pesticides and PCBs in Soil

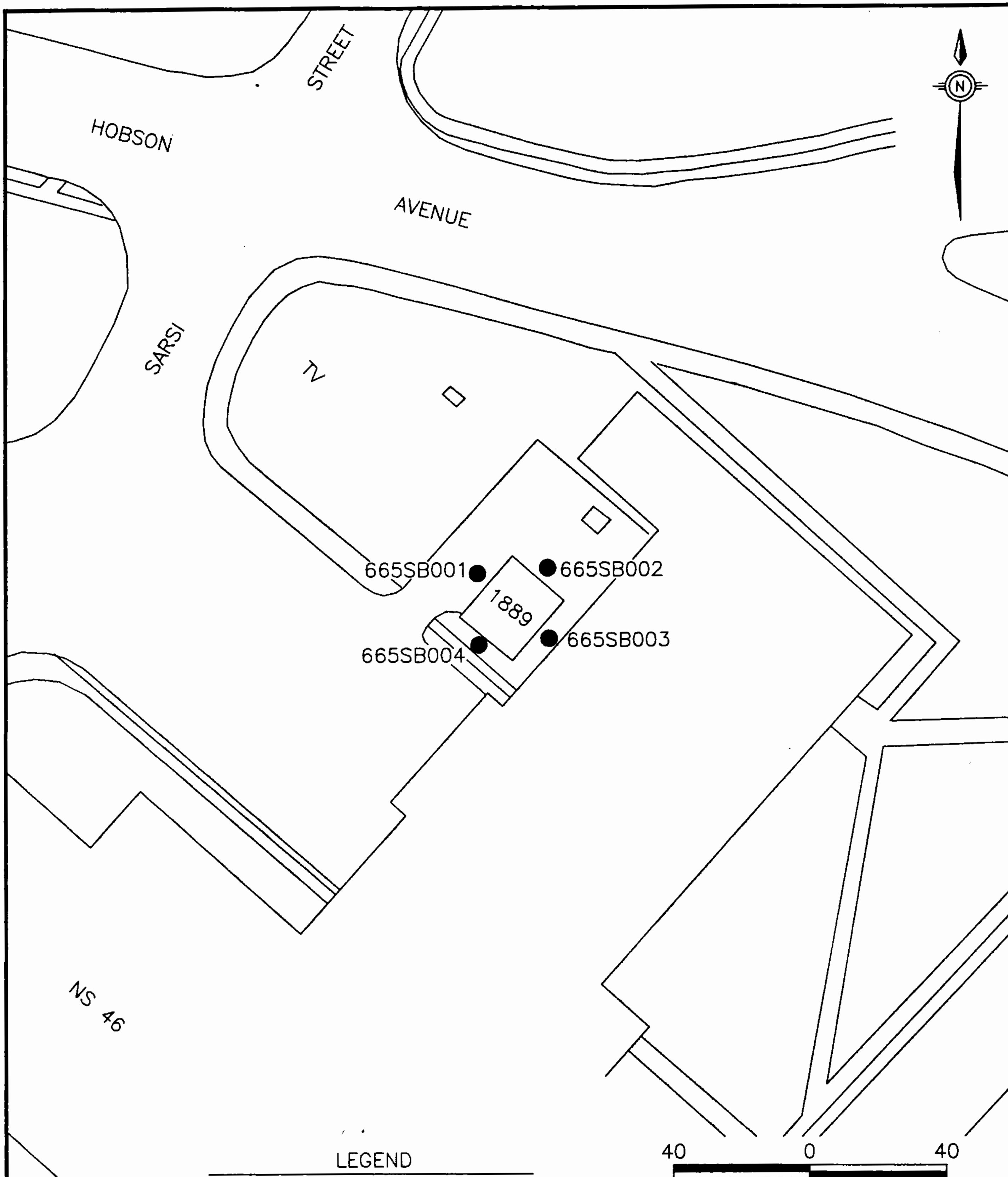
Pesticides were detected in all four sampling locations at AOC 665 and in five of the eight samples analyzed. Six pesticides were detected. Of the five pesticide detections, three were from the 0-to 1-foot depth interval and two samples were from the 3- to 5-foot depth interval. The combined total of alpha- and gamma-chlordane (RBSL= 470 μg/kg) was detected at 1,320 μg/kg in the second interval of sample location 665SB003. The remaining detections ranged from one to three orders of magnitude below their respective RBSLs.

No PCBs were detected in the soil samples collected at AOC 665.

4.18.1.4 Other Organic Compounds in Soil

TPH analysis identified petroleum hydrocarbons at two of the four sample locations and in two of the eight samples analyzed. Petroleum hydrocarbons were detected in the 0 -to 1-foot depth interval at sample locations 665SB002 and 665SB003, at concentrations ranging from 94,000 to 200,000 μg/kg.

Herbicides or organophosphate pesticides were not detected in the duplicate soil sample collected at AOC 665.



LEGEND

● – SOIL SAMPLE LOCATION

ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4.18.1
AOC 665
SOIL SAMPLE LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH04

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Dioxin was detected in the sample submitted for duplicate analysis (665CB002). The TEQ for the sample was 0.571 pg/g (screening level 1,000 pg/g).

4.18.1.5 Inorganic Elements in Soil

Table 4.18.2 summarizes the inorganic element analysis results from the soil samples collected at AOC 665. No elements were detected at concentrations exceeding their respective RBSLs and interval-specific UTLs for background.

Cyanide or hexavalent chromium were not detected in the soil samples collected at AOC 665.

4.18.2 Deviations from Final Zone H RFI Work Plan

All soil samples that were proposed to be collected in the Final Zone H RFI Work Plan were collected.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.18.1
AOC 665
Organic Compounds in Soil (in μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
Acetone	2/3	34-210/40-96	780,000
Toluene	2/3	3.9-4.2/6.3-10	1,600,000
Semivolatile Organic Compounds *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
Benzo(a)anthracene	1/0	170/0	880
Benzo(b)fluoranthene	1/0	120/0	880
Benzo(k)fluoranthene	1/0	150/0	8800
Benzo(g,h,i)perylene	1/0	100/0	310,000
Benzo(a)pyrene	2/0	77-120/0	88
bis(2-Ethylhexyl)phthalate (BEHP)	1/1	130/150	46,000
Chrysene	1/0	170/0	88,000
Fluoranthene	1/0	370/0	310,000
Indeno(1,2,3-cd)pyrene	1/0	81/0	880
Pyrene	1/0	280/0	230,000
Pesticides *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Sample, 1 Sample Duplicated)*			
4,4'-DDE	3/1	4-8/3	1,900
4,4'-DDT	3/0	10-13/0	1,900
alpha-Chlordane	3/1	3-11/670	470 (alpha + gamma)
gamma-Chlordane	3/1	4-18/650	
Endosulfan II	1/0	4/0	47,000
Heptachlor epoxide	1/0	8/0	70

Table 4.18.1
AOC 665
Organic Compounds in Soil (in μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Polychlorinated Biphenyls *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
No PCBs detected.			
Total Petroleum Hydrocarbons *(8 Samples Collected — 4 Upper Interval Samples, 4 Lower Interval Samples, 1 Sample Duplicated)*			
Total Petroleum Hydrocarbons (IR)	2/0	94,000-200,000	Not Listed
Herbicides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No herbicides detected.			
Organophosphate Pesticides *(1 Duplicate Analysis — 1 Lower Interval Sample)*			
No organophosphates detected.			
Dioxin *(1 Duplicate Analysis — 1 Lower Interval Sample)*			
Total TEQ	0/1	0/0.571 pg/g	1000 pg/g

Table 4.18.2
AOC 665
Inorganic Elements in Soil (in mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	4/4	4/4	4,540-8,000/830-2,830	7,900	25,310/46,180
Iron[a]	4/4	4/4	2,430-8,510/2,060-6,250	Not Listed	30,910/66,170
Lead	4/4	4/3	4.3-51.4/2.2-5.3	400	118/68.69
Nickel	4/4	4/4	1.6-10.1/1.0-6.4	160	33.38/29.9
Potassium[a]	4/4	0/0	0/0	Not Listed	Nutrient[e]
Silver	4/4	0/0	0/0	39	Not Valid[d]
Sodium[a]	4/4	4/4	27.1-246/133-538	Not Listed	Nutrient[e]
Thallium	4/4	0/0	0/0	0.63	0.63/1.3
Antimony	4/4	0/1	0/1.4	3.1	Not Valid[d]
Arsenic	4/4	4/4	1.3-7.9/3.3-9.0	0.37	14.81/35.52
Barium	4/4	4/2	8.0-14.1/4.1-5.1	550	40.33/43.80
Beryllium	4/4	4/4	0.04-0.24/0.16-0.31	0.15	1.466/1.62
Cadmium	4/4	1/1	0.81/0.19	3.9	1.05/1.10
Cobalt	4/4	4/4	1.1-1.6/0.38-1.0	470	5.863/14.88
Copper	4/4	4/4	1.6-39.1/0.64-10.2	290	27.6/31.62
Vanadium	4/4	4/4	10.2-36.9/3.8-15.5	55	77.38/131.6
Zinc	4/4	2/2	23-111/18-34.5	2,300	214.3/129.6
Selenium	4/4	0/0	0/0	39	2.0/2.7
Mercury	4/4	3/2	0.03-0.1/0.02-0.05	2.3	0.485/0.74
Magnesium[a]	4/4	4/4	161-908/201-2,110	Not Listed	9,592/9,179
Manganese[a]	4/4	4/4	5.9-63.9/22-135	39	636.4/1,412
Calcium	4/4	4/4	1,200-23,400/8,790-126,000	Not Listed	Nutrient[e]
Chromium	4/4	4/4	5.9-17.4/4.0-20.7	39	85.65/83.86
Tin[a]	0/1	0/1	0/2.2	4,700	Not Valid[d]
Hexavalent Chromium[b]	0/1	0/0	0/0	39	Not Valid[d]
Cyanide	4/4	0/0	0/0	160	Not Valid[d]

Notes:
[a] = Elements that are not included in both SW-846 and Appendix IX methods.
[b] = Included in duplicate sample analyses only.
[c] = See Appendix J for UTL determination.
[d] = Number of nondetections prevented determination of UTL.
[e] = Elements considered to be nutrients, therefore UTL was not determined.

4.19 AOC 667 and SWMU 138

AOC 667 and SWMU 138, because of their proximity, have been investigated together. AOC 667, the vehicle maintenance area, is a two-story brick structure (Building 1776) with an oil-water separator. The site is used for the routine maintenance of automobiles and heavy equipment, including oil changes and repairing hydraulic parts from the equipment. A 550-gallon portable storage tank holds waste oil. Numerous oil stains have been noted around the building. SWMU 138, the SAA related to Building 1776, stores hazardous waste in 55-gallon drums which are immediately transferred to a permitted hazardous waste storage facility.

Soil and groundwater were sampled at AOC 667 and SWMU 138 to determine if contamination resulted from petroleum product storage and dispensing at the storage tank or other releases at the sites.

4.19.1 Soil Sampling and Analysis

Soil was sampled in a single phase at AOC 667 and SWMU 138 from locations shown on Figure 4.19.1 in accordance with the procedures outlined in Section 2.2. Tables 4.19.1 and 4.19.2 summarize organic and inorganic results, respectively, for soil. Appendix I presents a complete analytical report for the samples collected at AOC 667 and SWMU 138.

Fourteen soil samples were collected from seven locations. Of the 14 soil samples collected, seven were collected from the 0- to 1-foot interval and seven samples were from the 3- to 5-foot interval. Sampling locations were selected relative to the storage tank and the SAA in areas most likely to have been impacted if a release occurred. Samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. Two samples selected as duplicates were analyzed for herbicides, hexavalent chromium, organophosphate pesticides, and dioxins, in addition to the standard suite of analyses.

4.19.1.1 Volatile Organic Compounds in Soil

VOCs were detected at seven different sampling locations, and in all 14 samples analyzed. Of the 14 detections, seven were collected from the 0- to 1-foot interval and seven were from the 3- to 5-foot interval. Seven VOCs were detected and concentrations ranged from two to eight orders of magnitude below their respective RBSLs.

4.19.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected in six of the seven sampling locations, and seven of all 14 samples analyzed. Of the seven detections, five samples were from the 0- to 1-foot interval and two were from the 3- to 5-foot interval. Benzo(a)pyrene was the only one exceeding its RBSL. This compound was detected at 153 μg/kg (RBSL=88 μg/kg) in the first interval sample collected at sample location 138SB003. The remaining 10 SVOCs were at least four orders of magnitude below their respective RBSLs.

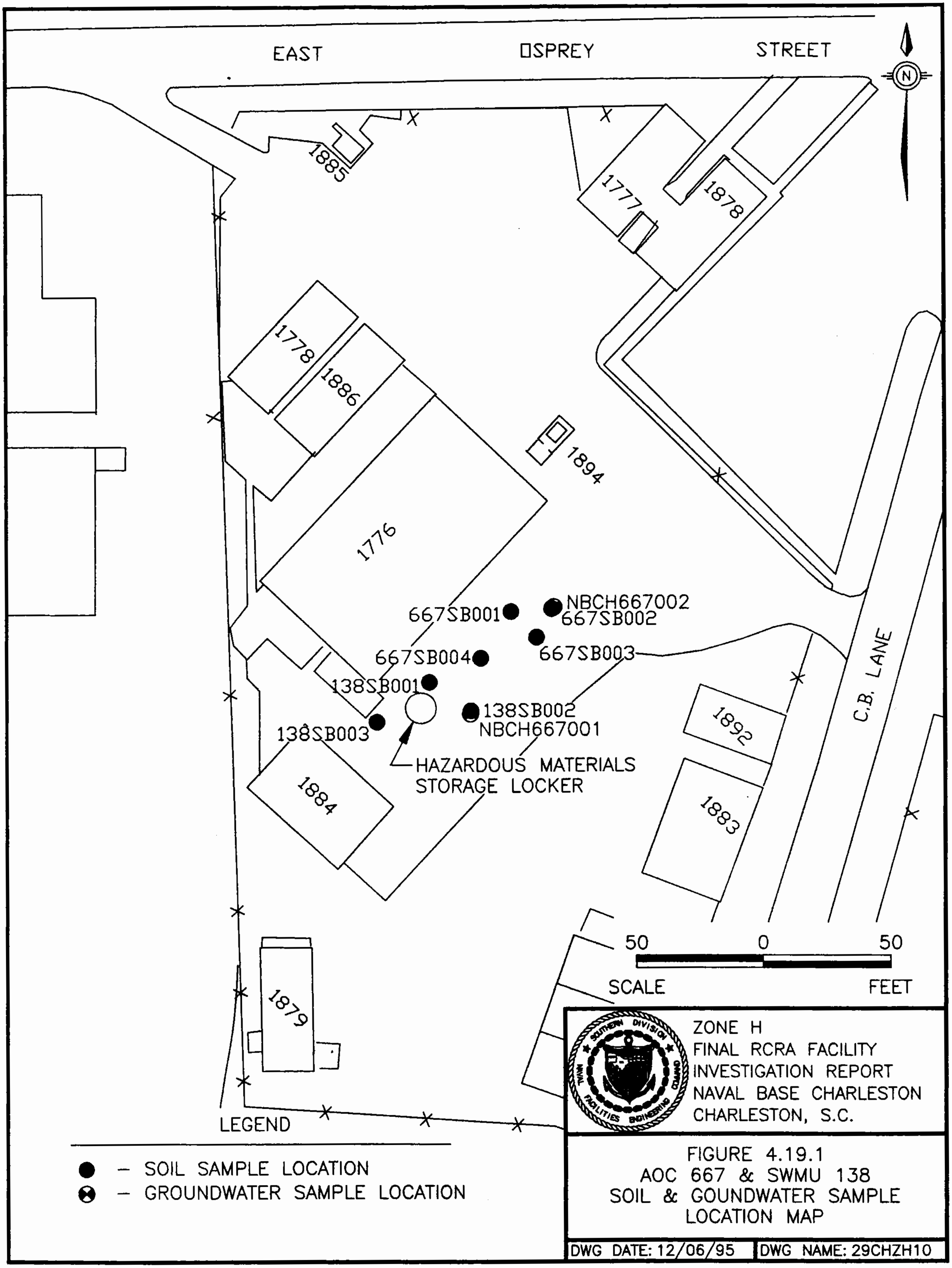
4.19.1.3 Pesticides and PCBs in Soil

Five pesticides were detected in five of the seven soil sample locations and in six of the 14 samples analyzed. Of the six detections, five samples were from the 0- to 1-foot depth interval and one from the 3- to 5-foot depth interval. All were from one to three orders of magnitude below their respective RBSLs, except 4,4'-DDT, which had a detection of 1,140 μg/kg and an RBSL of 1,900 μg/kg.

No PCBs were detected in the soil samples collected at AOC 667 and SWMU 138.

4.19.1.4 Other Organic Compounds in Soil

TPH analysis identified petroleum hydrocarbons in the duplicate sample locations (138CB002 and 667CB002). The petroleum hydrocarbons were detected in the 0- to 1-foot depth interval at concentrations ranging from 200,000 to 1,800,000 μg/kg.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
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FIGURE 4.19.1
AOC 667 & SWMU 138
SOIL & GOUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH10

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Herbicides were detected in both duplicate samples (138CB002 and 667CB002) from the 0- to 1-foot interval. Silvex (RBSL=63,000 μg/kg) was detected in one sample (138CB002) at a concentration of 7.9 μg/kg. 2,4,5-T (RBSL=78,000 μg/kg) was detected in one sample (667CB002) at a concentration of 8.5 μg/kg.

No organophosphate pesticides were detected in soil samples duplicated at AOC 667 and SWMU 138.

Dioxins were detected in both of the samples submitted for duplicate analysis (138CB00201 and 667CB00202). The TEQs were 1.038 and 6.689 pg/g, respectively (screening level 1,000 pg/g).

4.19.1.5 Inorganic Elements in Soil

Table 4.19.2 summarizes the inorganic element analytical results from the soil samples collected at AOC 667 and SWMU 138. Beryllium was the only element detected at a concentration exceeding its RBSL and interval-specific UTL.

Cyanide was detected at one of the seven sampling locations, and in one of the 14 samples analyzed. The detection was two orders of magnitude below the RBSL.

Hexavalent chromium was not detected in the duplicate soil samples collected at AOC 667 and SWMU 138.

4.19.2 Groundwater Sampling and Analysis

Two monitoring wells were installed to sample groundwater at AOC 667 and SWMU 138 (Figure 4.19.1) in accordance with the procedures outlined in Section 2.4 of this report. First-round samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. Based on the analytical results of the first round, second-round samples were analyzed for VOCs and metals. One second-round sample was duplicated and analyzed for the same parameters as the primary samples. Tables 4.19.3 and 4.19.4 summarize organic and inorganic results, respectively, for groundwater. Appendix I contains a complete report of the analytical data for groundwater samples collected from AOC 667 and SWMU 138.

4.19.2.1 Volatile Organic Compounds in Groundwater

Two VOCs, chloroethane and 1,1-dichloroethane, were reported in the groundwater samples from monitoring wells NBCH667001 and NBCH667002. Detections for chloroethane in well NBCH667002 were 150 and 74 μg/L for first and second-round samples, respectively, and did not exceed the RBSL of 860 μg/L. Detections of 1,1-dichloroethane were 3.4 and 17 μg/L, respectively, in samples from monitoring wells NBCH667001 and NBCH667002 in the first round and 9 μg/L from well NBCH667002 in the second round. The reported values for 1,1-dichloroethane did not exceed its RBSL for tap water of 81 μg/L. No other VOCs were detected in the groundwater samples at AOC 667 and SWMU 138.

4.19.2.2 Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in the groundwater sample results for wells at AOC 667 and SWMU 138.

4.19.2.3 Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in groundwater sample results for wells at AOC 667 and SWMU 138.

4.19.2.4 Other Organic Compounds in Groundwater

No petroleum hydrocarbons were detected in the groundwater sample results for wells at AOC 667 and SWMU 138.

4.19.2.5 Inorganic Elements in Groundwater

Table 4.19.4 summarizes the analytical results for inorganics in the groundwater samples collected at AOC 667 and SWMU 138. Manganese (RBSL - 18 μg/L) was the only inorganic element exceeding its RBSL. First-round samples from monitoring wells NBCH667001 and NBCH667002 had concentrations of 36.7 and 58.2 μg/L, respectively, while second-round samples from NBCH667001 and NBCH667002 had concentrations of 60.9 and 155 μg/L, respectively. No manganese detection exceeded its UTL.

No cyanide was detected in the groundwater samples collected at AOC 667 and SWMU 138.

4.19.3 Deviations from Final Zone H RFI Work Plan

All soil samples that were proposed to be collected in the Final Zone H RFI Work Plan were collected.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.19.1
AOC 667 and SWMU 138
Organic Compounds in Soil (mg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds *(14 Samples Collected — 7 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
Acetone	6/7	34-120/21.1-780	780,000
Carbon disulfide	1/0	4.6/0	780,000
1,1-Dichloroethane	1/2	10/19-74	780,000
Methylene chloride	1/2	12.9/5-12.4	85,000
2-Butanone (MEK)	2/1	6.9-9/6.83	4,700,000
Toluene	5/3	2.3-13.13/5-6	1,600,000
Xylene (total)	1/0	2.4/0	16,000,000
Semivolatile Organic Compounds *(14 Samples Collected — 7 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
Fluorene	0/1	0/720	310,000
Phenanthrene	2/1	50.8-55.8/1,000	310,000
Di-n-butylphthalate	1/0	64/0	780,000
Fluoranthene	1/0	117/0	310,000
Pyrene	1/0	89.1/0	230,000
Naphthalene	0/1	0/670	310,000
4-Chloro-3-methylphenol	1/0	72/0	Not Listed
2-Methylnapthalene	0/1	0/2,600	310,000
BEHP	2/1	310-480/111	46,000
Benzo(b)fluoranthene	1/0	214/0	880
Benzo(a)pyrene	1/0	153/0	88
Pesticides *(14 Samples Collected — 7 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
4,4'-DDD	3/1	4-11.4/18.1	2,700
4,4'-DDE	4/0	2-632/0	1,900

Table 4.19.1
AOC 667 and SWMU 138
Organic Compounds in Soil (mg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Levels
Pesticides *(14 Samples Collected — 7 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
4,4'-DDT	2/1	25.7-1,140/8.99	1,900
alpha-Chlordane	1/0	3/0	470 alpha + gamma
gamma-Chlordane	2/0	2-4.8/0	
Polychlorinated Biphenyls *(14 Samples Collected — 7 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
No PCBs detected.			
Total Petroleum Hydrocarbons *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
Total Petroleum Hydrocarbons	2/0	200,000-1,800,000/0	not listed
Herbicides *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
2,4,5-TP (Silvex)	2/0	7.9-7.9/0	63,000
2,4,5-T	1/0	8.5/0	78,000
Organophosphate Pesticides *(2 Duplicate Analyses — 2 Upper Interval Samples*			
No organophosphates detected.			
Dioxins *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
Total TEQ	2/0	1.038-6.689/0 pg/g	1000 pg/g

Table 4.19.2
AOC 667 and SWMU 138
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[(c)]
Aluminum[(a)]	7/7	7/7	1,820-3,350/3,640-6,870	7,900	25,310/ 46,180
Iron[(a)]	7/7	7/7	1,850-7,460/4,580-7,710	Not Listed	30,910/46,180
Lead	7/7	7/1	2.8-56.7/14.4	400	118/68.69
Nickel	7/7	5/7	1.7-9.3/6.6-25.5	160	33.38/29.9
Potassium[(a)]	7/7	0/0	0/0	Not Listed	Nutrient[(e)]
Silver	7/7	0/0	0/0	39	Not Valid[(d)]
Sodium[(a)]	7/7	7/7	17.1-331/567-2,120	Not Listed	Nutrient[(e)]
Thallium	7/7	0/0	0/0	0.63	0.63/1.3
Antimony	7/7	2/1	1.1-1.4/10.4	3.1	Not Valid[(d)]
Arsenic	7/7	7/7	0.92-8.5/6.6-10.0	0.37	14.81/35.52
Barium	7/7	6/3	6.4-175/1-8.7	550	40.33/43.80
Beryllium	7/7	7/7	0.03-1.5/0.31-1.21	0.15	1.466/1.62
Cadmium	7/7	2/5	0.35-0.36/0.31-0.46	3.9	1.05/1.10
Cobalt	7/7	7/6	0.28-3.4/0.9-2.5	470	5.863/14.8
Copper	7/7	7/5	1.6-34.85/4.3-8.1	290	27.6/31.62
Vanadium	7/7	7/7	6.0-15.5/11.4-42.9	55	77.38/131.6
Zinc	7/7	7/7	3.9-212.75/15.2-54.4	2,300	214.3/129.6
Selenium	7/7	0/3	0/1.1-2.3	39	2.0/2.7
Mercury	7/7	6/0	0.02-0.03/0	2.3	0.485/0.74
Magnesium[(a)]	7/7	6/7	83.5-3,150/2,450-9,700	Not Listed	9,592/9,179
Manganese[(a)]	7/7	7/7	7.9-152/51-123	39	636.4/1,412
Calcium	7/7	7/7	1,300-202,000/118,000-205,000	Not Listed	Nutrient[(e)]
Chromium	7/7	7/7	3.1-56.7/15.4-59.9	39	85.65/83.86
Tin[(a)]	2/0	0/0	0/0	4,700	Not Valid[(d)]
Hexavalent Chromium[(b)]	2/0	0/0	0/0	39	Not Valid[(d)]
Cyanide	7/7	1/0/0	3.8/0	160	Not Valid[(d)]

Notes:
[(a)] = Elements that are not included in both SW-846 and Appendix IX methods.
[(b)] = Included in duplicate sample analyses only.
[(c)] = See Appendix J for UTL determination.
[(d)] = Number of nondetections prevented determination of UTL.
[(e)] = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.19.3
AOC 667 and SWMU 138
Organic Compounds in Groundwater (μg/L)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds (Collected in Rounds 1 and 2)					
Chloroethane	1	1	150	860	Not Listed
	2	1	74		
1,1-Dichloroethane	1	2	3.4-17	81	Not Listed
	2	1	9		
Semivolatile Organic Compounds (Collected in Round 1 Only)					
No SVOCs detected.					
Pesticides (Collected in Round 1 Only)					
No pesticides detected.					
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Collected in Round 1 Only)					
No TPH detected.					

Table 4.19.4
AOC 667 and SWMU 138
Inorganic Elements in Groundwater (μg/L)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 0 Samples Duplicated

Compound Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Barium	1	2	12.9-61.4	260	323	2,000
	2	2	18.2-47.9			
Calcium[c]	1	2	113,000-154,000	Not	Nutrient	Not
	2	2	81,900-114,000	Listed		Listed
Iron	1	2	86.2-361	Not	45,760	Not
	2	2	38.6-853	Listed		Listed
Magnesium	1	2	90,600-144,000	Not	3,866,000	Not
	2	2	121,000-232,000	Listed		Listed
Manganese	1	2	36.7-58.2	18	3,391	Not
	2	2	60.9-155			Listed
Potassium[c]	1	2	41,600-66,100	Not	Nutrient	Not
	2	2	50,600-91,800	Listed		Listed
Sodium[c]	1	2	584,000-1,500,000	Not	Nutrient	Not
	2	2	1,220,000-2,580,000	Listed		Listed
Vanadium[d]	1	0	--	26	Not Valid	Not
	2	2	3.4-5.3			Listed
Cyanide[d]	1	--	Not Detected			
	2	--	No Analysis			

Notes:
[a] = Only elements with detections are listed. Cyanide was a separate analysis.
[b] = See Appendix J for UTL determinations.
[c] = Element considered to be a nutrient; therefore UTL was not determined.
[d] = High percentage of nondetects in background samples prevented UTL determination.

4.20 AOC 666

AOC 666 is a UST (NS-45) which supplies fuel oil to the adjacent heating plant (NS-44). The exact capacity of the UST is unknown. The site was constructed in 1958; the surrounding area was an airstrip before then. AOC 666 is currently an area approximately 10 feet by 30 feet which is surrounded by railroad ties.

Soil and groundwater were sampled at AOC 666 to determine if contamination resulted from fuel oil storage and dispensing from the UST or other releases at the site.

4.20.1 Soil Sampling and Analysis

Soil was sampled in a single phase at AOC 666 at locations shown on Figure 4.20.1 in accordance with the procedures outlined in Section 2.2. Tables 4.20.1 and 4.20.2 summarize organic and inorganic results, respectively, for soil. Appendix I presents a complete analytical report for the samples collected at AOC 666.

Thirteen soil samples were collected from seven locations. Of the 13 soil samples collected, seven were from the 0- to 1-foot interval and six were from the 3- to 5-foot interval. Sampling locations were selected just off the sides of the UST in areas most likely to have been impacted if a release had occurred. Samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. One sample selected as a duplicate was analyzed for herbicides, hexavalent chromium, organophosphate pesticides, and dioxin in addition to the standard suite of analyses.

4.20.1.1 Volatile Organic Compounds in Soil

VOCs were detected in four of the seven sampling locations, and in five of all 13 samples analyzed. Of the six VOC detections, one was from the 0- to 1-foot interval and four were from the 3- to 5-foot interval. The VOC concentrations detected ranged from four to five orders of magnitude below their respective RBSLs.

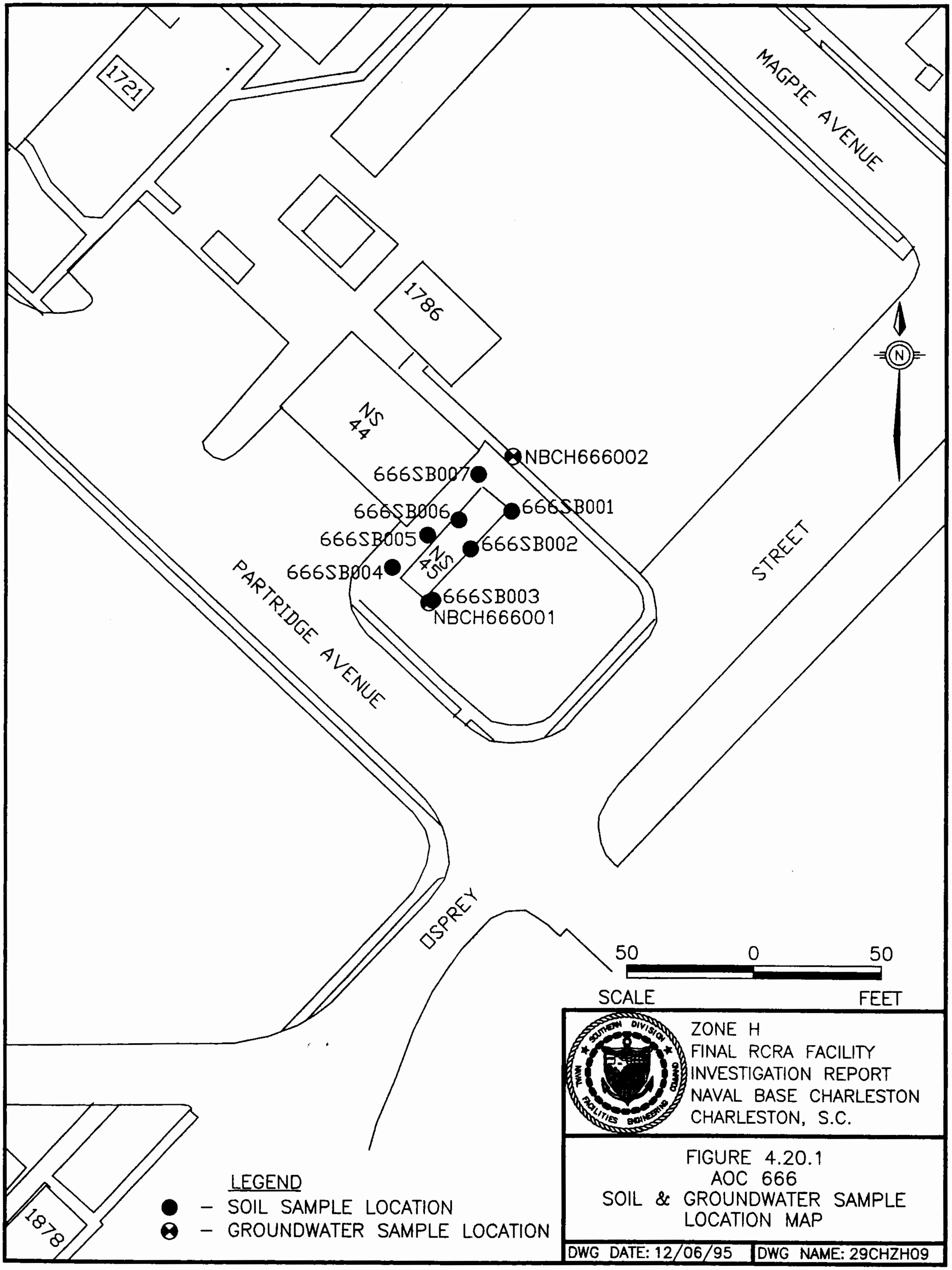
4.20.1.2 Semivolatile Organic Compounds in Soil

Twenty-four SVOCs were detected throughout the seven sampling locations, and in 10 of all 13 samples analyzed. Of the 10 samples in which SVOCs were detected, five were from the 0- to 1-foot interval and five samples were from the 3- to 5-foot interval. Benzo(b)fluoranthene, benzo(a)pyrene, and N-nitroso-di-n-propylamine were all detected above respective RBSLs. Benzo(b)flouranthene was detected at 2,400 μg/kg (RBSL=880 μg/kg) in the first interval sample collected at sample location 666SB002. Benzo(a)pyrene (RBSL=88 μg/kg) was detected at 196 and 1,180 μg/kg, respectively, in the first interval of sample locations 666SB001 and 666SB002 and at 1,750 μg/kg in the second interval of sample location 666SB002. N-Nitroso-di-n-propylamine (RBSL=91 μg/kg) was detected at 380 μg/kg in the first interval of sample location 666SB007. Except for benzo(a)anthracene, the remaining compounds were detected between one and five orders of magnitude below their RBSLs. Benzo(a)anthracene was detected at 481 μg/kg, compared to its RBSL of 880 μg/kg.

4.20.1.3 Pesticides and PCBs in Soil

Gamma-chlordane was detected in one of the 13 samples analyzed. The one soil sample was collected from the 0- to 1-foot depth interval at sample location 666SB004. Gamma-chlordane was detected at a concentration two orders of magnitude below its RBSL. No other pesticides were detected in the soil samples collected at AOC 666.

Aroclor-1260 was detected in one of the 13 samples analyzed. The one soil sample was collected from the 0- to 1-foot depth interval at sample location 666SB005. Aroclor-1260 was detected in this sample at a concentration of 88.4 μg/kg, slightly above its RBSL of 83 μg/kg. No other PCBs were detected in the soil sampling at AOC 666.



ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
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FIGURE 4.20.1
AOC 666
SOIL & GROUNDWATER SAMPLE
LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH09

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4.20.1.4 Other Organic Compounds in Soil

TPH analysis identified petroleum hydrocarbons at all seven sample locations and in 12 of the 13 samples analyzed. Of the 12 TPH detections, seven were from the 0- to 1-foot interval and five were from the 3- to 5-foot interval. TPH concentrations ranged from 91,000 to 30,000,000 μg/kg in the upper interval and 150,000 to 16,000,000 μg/kg in the lower interval.

No herbicides or organophosphate pesticides were detected at AOC 666.

Dioxin was detected in the sample submitted for duplicate analysis (666CB003). The TEQ for the sample was 5.42 pg/g (screening level 1,000 pg/g).

4.20.1.5 Inorganic Elements in Soil

Table 4.20.2 summarizes the inorganic element results from the soil samples collected at AOC 666. Elements exceeding both their respective RBSLs and interval-specific UTLs for background are arsenic and vanadium. Arsenic (RBSL=0.37 mg/kg; upper interval TL=14.81 mg/kg) was detected at 16.5 and 30.5 mg/kg in the first intervals of sample locations 666SB002 and 666SB004, respectively. Vanadium (RBSL=55 mg/kg; upper interval UTL=77.38 mg/kg, lower interval UTL=131.6 mg/kg) was detected at five sample locations and ranged from slightly greater than the interval-specific UTL and RBSL to one order of magnitude greater than the UTL and RBSL. Four were detected in the first interval of sample locations 666SB002, 666SB004, 666SB005, and 666SB007 and one was in the second interval of sample location 666SB007.

Cyanide was detected at one of the seven soil sample locations, and in one of the 13 samples analyzed. Cyanide was detected at 1.0 mg/kg, which is well below the RBSL of 160 mg/kg.

Hexavalent chromium was not detected in the duplicate sample analysis.

4.20.2 Groundwater Sampling and Analysis

Two monitoring wells were installed to sample the groundwater at AOC 666 (Figure 4.20.1) in accordance with the procedures outlined in Section 2.4. First-round samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. Based on results from the first sampling round, second-round samples were analyzed for VOCs, SVOCs, and metals only. One second-round sample was duplicated and analyzed for the same parameters as the primary samples. Tables 4.20.3 and 4.20.4 summarize organic and inorganic results, respectively, for groundwater. Appendix I presents a complete report of the analytical data for groundwater samples collected from AOC 666.

4.20.2.1 Volatile Organic Compounds in Groundwater

Two VOCs (chloromethane and vinyl chloride) were reported in the first-round groundwater samples at well location NBCH666001. The detections for each of these compounds, chloromethane at 6 μg/L and vinyl chloride at 2.1 μg/L, exceeded the corresponding RBSLs for tap water (1.4 μg/L and 0.019 μg/L, respectively). No VOCs were detected in second-round samples.

4.20.2.2 Semivolatile Organic Compounds in Groundwater

One SVOC (acenaphthene) was reported in a first-round groundwater sample collected from NBCH666001. The detection for this compound (14 μg/L) did not exceed the RBSL for tap water (220 μg/L). Acenaphthene also appeared in the second-round sample from NBCH666001 at a concentration of 8.85 μg/L.

4.20.2.3 Pesticides and PCBs in Groundwater

No pesticides or PCBs were reported in the groundwater samples collected at AOC 666 during the first sampling round. Pesticides/PCBs were not analyzed in the second-round samples.

4.20.2.4 Other Compounds in Groundwater

No petroleum hydrocarbons were detected in the first-round groundwater samples collected at AOC 666. Second-round samples were not analyzed for TPH.

4.20.2.5 Inorganic Elements in Groundwater

Table 4.20.4 summarizes the inorganic elements/compound results from the groundwater samples collected at AOC 666. The only element exceeding its RBSL in either sampling round was manganese (RBSL=18 μg/L). Samples from both wells in both rounds reported manganese concentrations above the RBSL but below the UTL. In the first round, manganese was detected at 43.4 μg/L in well NBCH66602 and at 102 μg/L in NBCH66601. In second-round samples, at 30.3 μg/L from NBCH666002 and manganese was detected at 78.4 μg/L from NBCH666001.

No cyanide was detected in first-round samples from AOC 666. Cyanide analysis was not performed on second-round samples.

4.20.3 Deviations from Final Zone H RFI Work Plan

Twelve soil samples were proposed to be collected in the Final Zone H RFI Work Plan. The actual number of soil samples collected at AOC 666 was 13 (seven upper interval, six lower interval). All proposed upper interval-samples were collected. Due to shallow depth to groundwater, only two of the second interval samples were collected from the proposed locations. Based on analytical data for soil samples collected during the initial phase, additional locations were identified. Both intervals were sampled at each of these additional sample locations.

Groundwater samples were collected from each of the sample locations proposed in the Final Zone H RFI Work Plan.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.20.1
AOC 666
Organic Compounds in Soil (in $\mu g/kg$)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st Interval/2nd Interval)	Risk-Based Screening Levels
Volatile Organic Compounds ***(13 Samples Collected — 7 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)***			
Acetone	0/2	0/8.12-9.64	780,000
Toluene	1/2	14/6-10	160,000
Semivolatile Organic Compounds ***(13 Samples Collected — 7 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)***			
Acenaphthene	1/0	380/0	470,000
Benzo(a)anthracene	1/0	481/0	880
Benzo(b)fluoranthene	2/0	181-2,400/0	880
Benzo(g,h,i)perylene	1/0	166/0	310,000
Benzo(a)pyrene	2/1	196-1,180/1,750	88
bis(2-Ethylhexyl)phthalate (BEHP)	1/1	116/137	46,000
Butylbenzylphthalate	1/0	57.8/0	1,600,000
4-Chloro-3-methylphenol	1/0	380/0	Not Listed
2-Chlorophenol	1/0	3,800/0	39,000
Chrysene	2/0	133-1,730/0	88,000
Diethylphthalate	0/1	0/84	6,300,000
Di-n-butylphthalate	4/1	60.5-567/587	780,000
1,4-Dichlorobenzene	1/0	380/0	27,000
Di-n-octylphthalate	0/1	0/466	160,000
2,4-Dinitrotoluene	1/0	380/0	16,000
Fluoranthene	2/2	175-5,690/95-120	310,000
N-Nitroso-di-n-propylamine	1/0	380/0	91
4-Nitrophenol	1/0	380/0	480,000
Pentachlorophenol	1/0	380/0	5,300
Phenanthrene	2/0	44.8-1,080/0	310,000
Phenol	1/0	380/0	4,700,000
Semivolatile Organic Compounds ***(13 Samples Collected — 7 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)***			
Pyrene	3/2	147-4,320/86-98	230,000
1,2,4-Trichlorobenzene	1/0	380/0	78,000
2,4,6-Trichlorophenol	0/1	0/430	58,000

Table 4.20.1
AOC 666
Organic Compounds in Soil (in $\mu g/kg$)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations for Detections (1st Interval/2nd Interval)	Risk-Based Screening Levels
Pesticides *(13 Samples Collected — 7 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)*			
gamma-Chlordane	1/0	8.9/0	470
Polychlorinated Biphenyls *(13 Samples Collected — 7 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)*			
Aroclor-1260	1/0	88.4/0	83
Total Petroleum Hydrocarbons *(13 Samples Collected — 7 Upper Interval Samples, 6 Lower Interval Samples, 1 Sample Duplicated)*			
Total Petroleum Hydrocarbons (IR)	7/5	91,000-30,000,000/ 150,000-16,000,000	Not Listed
Herbicides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No herbicides detected.			
Organophosphate Pesticides *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
No organophosphates detected.			
Dioxin *(1 Duplicate Analysis — 1 Upper Interval Sample)*			
Total TEQ	1/0	5.420/0 pg/g	1000 pg/g

Table 4.20.2
AOC 666
Inorganic Elements in Soil (in mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	7/6	7/6	705-6,960/5,110-7,580	7,900	25,310/46,180
Iron[a]	7/6	7/6	603-6,240/1,070-6,060	Not Listed	30,910/66,170
Lead	7/6	5/4	3.2-118/3.4-5.8	400	118/69.69
Nickel	7/6	5/4	3.8-39.3/2.2-9.0	160	33.38/29.9
Potassium[a]	7/6	5/3	105-286/183-508	Not Listed	Nutrient[e]
Silver	7/6	0/0	0/0	39	Not Valid[d]
Sodium[a]	7/6	3/4	41.7-275/69.3-657	Not Listed	Nutrient[e]
Thallium	7/6	0/0	0/0	0.63	0.63/1.3
Antimony	7/6	4/2	1.5-2.0/1.4-2.3	3.1	Not Valid[d]
Arsenic	7/6	5/3	0.76-30.5/1.6-4.7	0.37	14.81/35.52
Barium	7/6	5/4	3.4-30.4/1.6-5.3	550	40.33/43.80
Beryllium	7/6	5/3	0.04-0.20/0.05-0.22	0.15	1.466/1.62
Cadmium	7/6	3/1	0.4-0.71/0.16	3.9	1.05/1.10
Cobalt	7/6	5/4	0.52-2.2/0.42-1.3	470	5.863/14.88
Copper	7/6	5/4	3.7-138/4.6-115	290	27.6/31.62
Vanadium	7/6	7/6	12.0-147/6.8-136	55	77.38/131.6
Zinc	7/6	6/4	4.6-285/3.2-21.7	2,300	214.3/129.6
Selenium	7/6	3/4	0.3-0.62/0.37-1.0	39	2.0/2.7
Mercury	7/6	5/2	0.03-2.3/0.04-0.05	2.3	0.485/0.74
Magnesium[a]	7/6	6/6	145-1,910/42.6-2,020	Not Listed	9,592/9,179
Manganese[a]	7/6	5/5	3.3-78.2/1.4-39.0	37	636.4/1,412
Calcium	7/6	7/6	939-56,900/101-80,500	Not Listed	Nutrient[e]
Chromium	7/6	5/4	5.2-35.1/4.6-18.2	39	85.65/83.86
Tin[a]	1/0	0/0	0/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	1/0	0/0	0/0	39	Not Valid[d]
Cyanide	7/6	0/1	0/1.0	160	Not Valid[d]

Notes:
[a] = Elements that are not included in both SW-846 and Appendix IX methods.
[b] = Included in duplicate sample analyses only.
[c] = See Appendix J for UTL determination.
[d] = Number of nondetections prevented determination of UTL.
[e] = Elements considered to be nutrients, therefore UTL was not determined.

Table 4.20.3
AOC 666
Organic Compounds in Groundwater (μg/L)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 1 Sample Duplicated

Compound Name	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds					
Chloromethane	1	1	6	1.4	Not Listed
	2	0	--		
Vinyl chloride	1	1	2.1	0.019	2
	2	0	--		
Semivolatile Organic Compounds					
Acenaphthene	1	1	14	220	Not Listed
	2	1	8.85		
Pesticides (Collected in Round 1 Only)					
No pesticides detected.					
Polychlorinated Biphenyls (Collected in Round 1 Only)					
No PCBs detected.					
Total Petroleum Hydrocarbons (Collected in Round 1 Only)					
No TPH detected.					

Table 4.20.4
AOC 666
Inorganic Chemicals in Groundwater (μg/L)

Round 1: 2 Samples Collected, 0 Samples Duplicated
Round 2: 2 Samples Collected, 1 Sample Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Barium	1 2	1 2	53.6 4.2-40.1	260	323	2000
Calcium[c]	1 2	2 2	87,900-111,000 67100-83200	Not Listed	Nutrient	Not Listed
Iron	1 2	2 2	259-1,600 122.35-1100	Not Listed	45,760	Not Listed
Magnesium	1 2	2 2	33,700-95,700 33650-91900	Not Listed	3,866,000	Not Listed
Manganese	1 2	2 2	43.4-102 30.3-78.4	18	3,391	Not Listed
Nickel[d]	1 2	0 1	– 21.8	73	Not Valid	100
Potassium[c]	1 2	2 2	17,600-47,500 15,550-42,800	Not Listed	Nutrient	Not Listed
Sodium[c]	1 2	2 2	88,900-1,010,000 87,400-1,120,000	Not Listed	Nutrient	Not Listed
Vanadium[d]	1 2	2 2	4.5-6.7 4.5-8.4	26	Not Valid	Not Listed
Zinc[d]	1 2	0 1	– 9.6	1,100	Not Valid	Not Listed
Cyanide[d]	1 2		Not Detected No Analysis			

Notes:

(a) = Only elements with detections are listed. Cyanide was a separate analysis.
(b) = See Appendix J for UTL determinations.
(c) = Element considered to be a nutrient; therefore, UTL was not determined.
(d) = High percentage of nondetects in background samples prevented determination of UTL.

4.21 SWMU 159

SWMU 159 is near Building 665 in the southcentral portion of Zone H. The unit is a former SAA which temporarily accumulated and stored hazardous materials. Materials stored at the site included batteries, aerosol cans, and paint waste. An AST containing diesel fuel, a can crusher, and small debris piles are also at the SWMU.

Soil, sediment, and surface water were sampled to assess any residual contamination from the former storage area. Soil was sampled in accordance with Section 2.2. Sediment and surface water were sampled in accordance with Section 2.5.

4.21.1 Soil Sampling and Analysis

Nineteen soil samples were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. Two of these samples were duplicated and analyzed for herbicides, hexavalent chromium, organophosphate pesticides, and dioxin. Sampling locations were selected to address the areas listed above. Four soil borings were advanced around the fence surrounding SWMU 159. One sample was collected at both the can crusher location and at a location where a pallet of batteries reportedly was to have been stored. Two soil samples were collected near the debris piles, and five soil borings were advanced throughout the site to provide spatial coverage. The remaining three soil borings were outside of the SWMU in areas which appeared to be unimpacted from site operations.

Table 4.21.1 (organic) and Table 4.21.2 (inorganic) summarize the analytical data for the soil samples collected near SWMU 159. Figure 4.21.1 identifies sampling locations at the SWMU. Appendix I contains all analytical data for SWMU 159.

4.21.1.1 Volatile Organic Compounds in Soil

Nineteen soil samples for VOC analysis were collected from the 0- to 1-foot depth interval. Three soil samples were collected from the 3- to 5-foot depth interval at SWMU 159. VOCs were detected in 14 of the upper soil samples and in three of the lower samples. Two VOCs (acetone and trichloroethene) were detected at concentrations ranging from three to four orders of magnitude below their respective RBSLs. Trichloroethene was the most commonly detected VOC.

4.21.1.2 Semivolatile Organic Compounds in Soil

SVOCs were detected in seven of the upper sampling locations and two of the lower sampling locations. Twelve SVOCs were detected in the soil samples collected at SWMU 159. Only one compound, benzo(a)pyrene (RBSL 88 μg/kg), exceeded the RBSL with a concentration of 100 μg/kg. This sample was from the upper interval at location 159SB011.

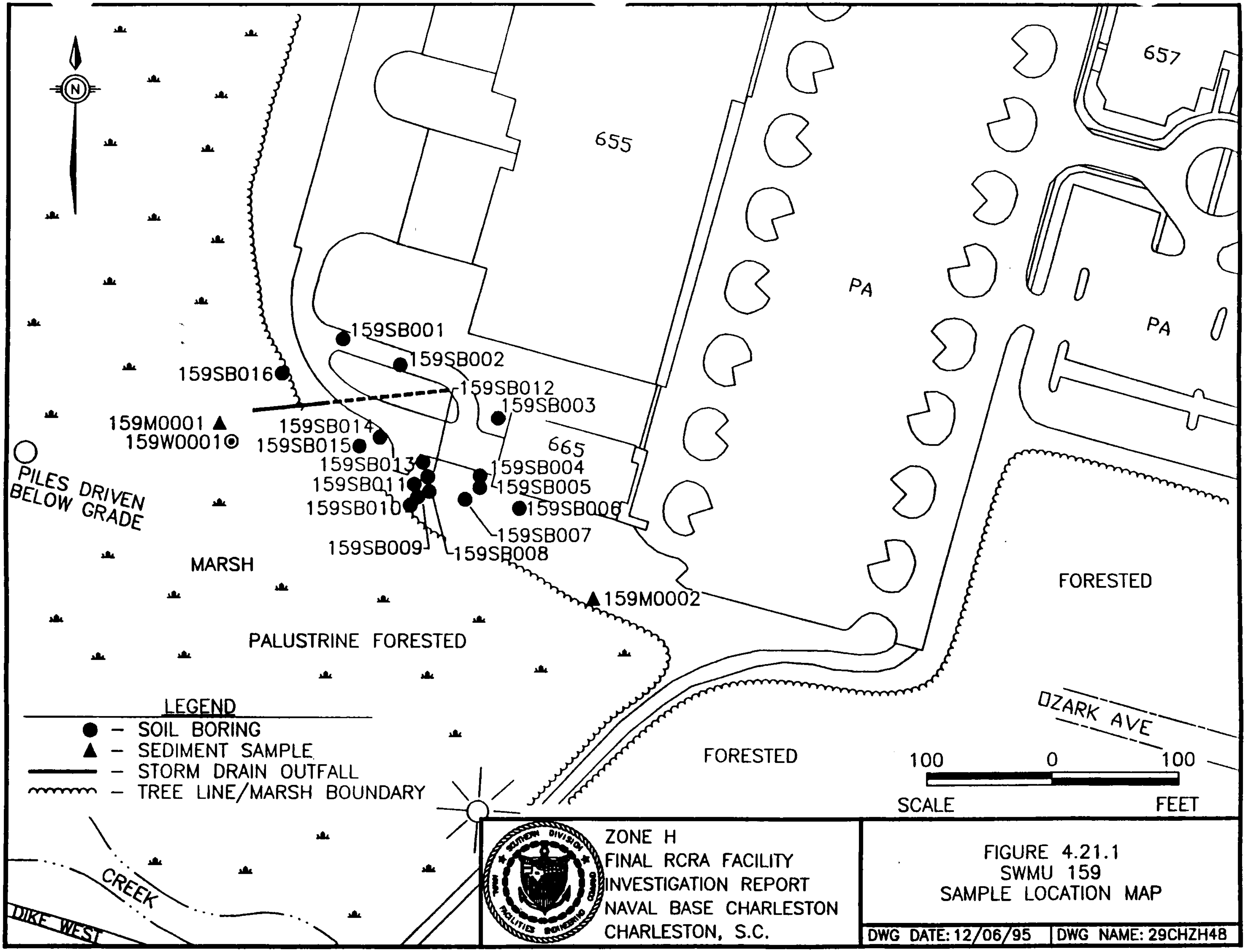
4.21.1.3 Pesticides and PCBs in Soil

Pesticides were detected in 15 of the upper-interval samples and three of the lower-interval samples. Seven pesticides were detected in soil samples collected at SWMU 159. Alpha-chlordane, gamma-chlordane, and 4,4' DDE were the most commonly detected pesticides. The concentrations of all of the pesticides detected ranged from less than one to four orders of magnitude below their respective RBSLs.

PCBs were not detected in any of the 19 samples collected.

4.21.1.4 Other Organic Compounds in Soil

No GRO were detected in any of the 19 samples. No organophosphate pesticides were detected in the two duplicate samples. However, indeterminate lubricating oils were detected in all 19 samples collected. Concentrations of indeterminate lubricating oils ranged from 29,000 μg/kg to 179,000 μg/kg. Herbicides were detected in both duplicate samples and were all at least three orders of magnitude below their RBSLs. Dioxins were detected in the two samples submitted for duplicate analyses. The dioxin total TEQs for the two samples were 3.540 and 8.905 pg/g, three orders of magnitude below the screening level of 1,000 pg/g.



ZONE H
FINAL RCRA FACILITY INVESTIGATION REPORT
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FIGURE 4.21.1
SWMU 159
SAMPLE LOCATION MAP

DWG DATE: 12/06/95 | DWG NAME: 29CHZH48

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4.21.1.5 Inorganic Elements in Soil

Inorganic elements were detected in all 19 samples collected. Aluminum was detected at a concentration exceeding its RBSL (7,800 mg/kg) and the UTL (25,310 mg/kg) for the upper interval. Cyanide was not detected in any of the 19 samples analyzed.

No hexavalent chromium was detected in the two duplicate sample analyses.

4.21.2 Sediment Sampling and Analysis

Sediment samples were collected from nearby water bodies to measure the potential impact from SWMU 159. Two sediment samples were collected, each from a depth of 0-to 1-foot below the sediment surface. Tables 4.21.3 and 4.21.4 summarize organic and inorganic results, respectively, for sediment. Appendix I contains a complete report of analytical data for Zone H. Sediment sampling locations are shown on Figure 4.1.1.

Concentrations of contaminants detected in the sediment were compared to USEPA Region IV SSVs. These values are shown on the accompanying tables and are intended to be only screening level comparisons to determine the need for further study. How they relate to ecological risk will be discussed further in Section 7 of this report.

The two sediment samples collected were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, organotin, cyanide, and TOC. The positions of all sediment sampling locations were based on areas most likely to have been impacted by a potential release from SWMU 159 or any other nearby SWMU.

4.21.2.1 Volatile Organic Compounds in Sediment

VOCs were detected in both of the sediment samples. Three different VOCs were detected in the sediment. None of the VOCs detected has a corresponding SSV.

4.21.2.2 Semivolatile Organic Compounds in Sediment

SVOCs were detected in both of the sediment samples. Twelve compounds were detected in the sediment samples. Pyrene, benzo(a)anthracene, phenanthrene, chrysene, and benzo(a)pyrene were detected at concentrations above their SSVs. Benzo(g,h,i)perylene and butylbenzylphthalate were detected at concentrations below their SSV. Fluoranthene, bis(2-ethylhexyl)pthalate, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected but do not have SSVs currently listed.

Pyrene (SSV 380 μg/kg) and chrysene (SSV 220 μg/kg) were detected in both samples at concentrations of 260 and 720 μg/kg and 190 and 510 μg/kg, respectively. Benzo(a)anthracene (SSV 160 μg/kg), phenanthrene (SSV 140 μg/kg), and benzo(a)pyrene (SSV 88 μg/kg) were each detected in the sediment sample collected at location 159M0002 at concentrations of 540 μg/kg, 310 μg/kg, and 470 μg/kg, respectively.

4.21.2.3 Pesticides and PCBs in Sediment

Four pesticides were detected in each of the samples. Three pesticides were detected at concentrations greater than their SSVs. The maximum concentrations of alpha-chlordane, gamma-chlordane, and heptachlor epoxide were 560 μg/kg, 760 μg/kg, and 72 μg/kg, respectively.

No PCBs were detected in the sediment sample locations.

4.21.2.4 Other Organic Compounds in Sediment

No petroleum hydrocarbons (TPH) were detected in either of the two samples collected. Analysis of the samples for oils showed indeterminate lubricating oil (no SSV) to be present at values between 52,000 μg/kg and 2,000,000 μg/kg.

4.21.2.5 Inorganic Elements in Sediment

Both sediment samples contained metals above their SSVs. A total of twenty-two metals were detected in the samples at concentrations above their screening levels. These included copper (SSV 28 mg/kg), lead (SSV 21 mg/kg), antimony (SSV 2 mg/kg), arsenic (SSV 8 mg/kg), zinc (SSV 68 mg/kg), mercury (SSV 0.1 mg/kg), and chromium (SSV 33 mg/kg).

Cyanide was not detected in either sample.

4.21.3 Surface Water Sampling and Analysis

One surface water sample was collected at SWMU 159. The sample was collected near the storm drain outfall to measure the potential impact from adjacent SWMUs. The sample was collected from 0 to 1 foot below the water surface. Tables 4.21.5 and 4.21.6 summarize the organic and inorganic results, respectively, for surface water. Appendix I contains a complete report of analytical data for Zone H. Surface water sampling locations are shown on Figure 4.21.1.

Concentrations of contaminants detected in the surface water were compared to USEPA chronic marine surface water quality criteria. These values are shown on Tables 4.21.5 and 4.21.6 and are intended to be only a screening level comparison to determine the need for further study. Water quality criteria and how they relate to ecological risk will be discussed further in the Zone J RFI report.

The surface water sample was collected and analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. The position of the surface water sampling location was based on the area most likely to have been impacted by a potential release from SWMU 159 or any other nearby SWMU.

4.21.3.1 Volatile Organic Compounds in Surface Water

VOCs were not detected in the sample.

4.21.3.2 Semivolatile Organic Compounds in Surface Water

SVOCs were not detected in the sample.

4.21.3.3 Pesticides and PCBs in Surface Water

Pesticides and PCBs were not detected in the sample.

4.21.3.4 Other Organic Compounds in Surface Water

No other organic compounds were detected in the surface water sample.

4.21.3.5 Inorganic Elements in Surface Water

Eleven metals were detected in the surface water sample. No metals with SSVs were detected at concentrations above the chronic marine quality criteria. However, only two (arsenic and zinc) of the 11 metals detected in the surface water sample had chronic marine quality criteria values. Cyanide was not detected in any of the surface water sample locations.

4.21.4 Deviations from Final Zone H RFI Work Plan

Thirty-two soil samples were proposed for collection in the Final Zone H RFI Work Plan. The actual number of soil samples collected at AOC 656 was 19 (16 upper interval, three lower interval). All proposed upper-interval samples were collected. Due to shallow depth to groundwater, only some of the second interval samples were collected from the proposed locations.

All proposed sediment and surface water samples were collected.

Table 4.0.3 lists the quantities of proposed samples and quantities of actual samples collected.

Table 4.21.1
SWMU 159
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Level
Volatile Organic Compounds ***(19 Samples Collected — 16 Upper Interval Samples, 3 Lower Interval Samples, 2 Samples Duplicated)***			
Acetone	1/3	41/67-180	780,000
Trichloroethene	14/2	3.3-21/9-20	47,000
Semivolatile Organic Compounds ***(19 Samples Collected—16 Upper Interval Samples, 3 Lower Interval Samples, 2 Samples Duplicated)***			
Acenaphthene	0/2	430	470,000
Anthracene	0/2	380-480	2,300,000
Benzo(a)anthracene	1/2	160/250-280	880
Benzo(b)fluoranthene	1/0	100	880
Benzo(k)fluoranthene	1/2	130/140-190	8800
Benzo(a)pyrene	2/2	19.5-100/26.62-30.14	88
bis(2-Ethylhexyl)phthalate (BEHP)	4/0	100-190	46,000
Chrysene	2/2	150-180/220-240	88,000
Fluoranthene	3/2	14.6-130/1200	310,000
Fluorene	0/1	230	310,000
Phenanthrene	1/1	310/200	310,000
Pyrene	3/2	11.8-96/930-960	230,000
Pesticides ***(19 Samples Collected — 16 Upper Interval Samples, 3 Lower Interval Sample, 2 Samples Duplicated)***			
alpha-Chlordane	12/1	4.1-120/3.1	470 alpha + gamma
gamma-Chlordane	12/1	1.9-130/5.3	
4,4'-DDE	12/3	2.2-16.0/3.2-4.3	1,900
4,4'-DDT	3/0	3.8-5.6	1,900
Endrin	1/0	2.5	2,300
Heptachlor	1/0	2.3	140
Heptachlor epoxide	2/0	2.7-3.6	70

Table 4.21.1
SWMU 159
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Level
Polychlorinated Biphenyls *(19 Samples Collected — 16 Upper Interval Samples, 3 Lower Interval Samples, 2 Samples Duplicated)*			
No PCBs Detected.			
Total Petroleum Hydrocarbons-Gasoline Range Organics *(19 Samples Collected — 16 Upper Interval Samples, 3 Lower Interval Samples, 2 Samples Duplicated)*			
No Total Petroleum Hydrocarbons-Gasoline Range Detected.			
Herbicides *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
2,4-D	1/0	20.2	78000
2,4,5-TP (Silvex)	2/0	12.9-30	**63,000**
2,4,5-T	2/0	11.3-53.5	**78,000**
Organophosphate Pesticides *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
No organophosphates detected.			
Indeterminate Lubricating Oils, Light Petroleum Hydrocarbons *(19 Samples Collected — 16 Upper Interval Samples, 3 Lower Interval Samples, 2 Samples Duplicated)*			
Indeterminate Lubricating Oil	16/3	29,000-170,000/68,000-110,000	Not Listed
Dioxin *(2 Duplicate Analyses — 2 Upper Interval Samples)*			
Total TEQ	2	3.539-8.905 pg/g	1,000 pg/g

Table 4.21.2
SWMU 159
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	16/3	16/3	3,190-29,300/11,900-30,200	7,900	25,310/46,180
Iron[a]	16/3	16/3	2,750-32,800/12,800-31,300	Not Listed	30,910/66,170
Lead	16/3	16/3	4.3-92/28.2-41	400	118/68.69
Nickel	16/3	16/3	0.94-16.3/14.6-20.6	160	33.38/29.90
Potassium[a]	16/3	2/3	579.0-1,670/1,390-2,210	Not Listed	Nutrient[e]
Silver	16/3	1/1	0.53/0.33	39	Not Valid[d]
Sodium[a]	16/3	13/0	111-2,500/4,250-6,760	Not Listed	Nutrient[e]
Thallium	16/3	0/0	0/0	0.63	0.63/1.3
Antimony	16/3	0/0	0/0	3.1	Not Valid[d]
Arsenic	16/3	16/3	0.78-12.8/7.7-12.6	0.37	14.81/35.52
Barium	16/3	14/3	11.5-47.1/41.6-81.2	550	40.33/43.80
Beryllium	16/3	3/3	0.11-1.2/0.78-1.3	0.15	1.466/1.62
Cadmium	16/3	9/3	0.12-0.41/0.84-1.1	3.9	1.05/1.1
Cobalt	16/3	1/3	6.4/3.5-5.9	470	5.86/14.88
Copper	16/3	10/3	2.1-46.1/13.8-16.2	290	27.6/31.62
Vanadium	16/3	15/3	3.9-62.6/31.2-65.3	55	77.38/131.6
Zinc	16.3	15/3	7.4-101/59.1-69.8	2,300	214.3/129.6
Selenium	16/3	16/3	0.44-2.3/2.3-3.6	39	2.0/2.7
Mercury	16/3	7/3	0.03-0.15/0.08-0.13	2.3	0.49/0.74
Magnesium[a]	16/3	16/3	168-4,860/5,480-10,800	Not Listed	9,592/9,179
Manganese[a]	16/3	16/3	11.7-307/88.3-247	39	636.4/1,412
Calcium	16/3	16/3	863-26,700/88,600-140,000	Not Listed	Nutrient[e]

Table 4.21.2
SWMU 159
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Chromium	16/3	16/3	4.5-72.3/30.2-68.1	39	85.65/83.86
Tin[a]	16/3	0/0	0/0	4,700	Not Valid[d]
Hexavalent Chromium[b]	2/0	0/0	0/0	39	Not Valid[d]
Cyanide	16/3	0/0	0/0	160	Not Valid[d]

Notes:
(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTLs.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.21.3
SWMU 159
Organic Compounds Detected in Sediment

Compound Name	No. of Detections	Range of Concentrations (μg/kg)	Sediment Screening Value (μg/kg)
Volatile Organic Compounds *(2 Samples Collected, 0 Samples Duplicated)*			
Acetone	1	210	—
Trichloroethene	1	17	—
2-Butanone	1	43	—
Semivolatile Organic Compounds *(2 Samples Collected, 0 Samples Duplicated)*			
Fluoranthene	2	230-920	—
Pyrene	2	260-720	380
Benzo(a)anthracene	1	540	160
Semivolatile Organic Compounds *(2 Samples Collected, 0 Samples Duplicated)*			
bis(2-Ethylhexyl)phthalate	2	280-2400	—
Phenanthrene	1	310	140
Indeno(1,2,3-cd)pyrene	1	270	—
Benzo(g,h,i)perylene	1	270	310,000
Chrysene	2	190-510	220
Butylbenzylphthalate	1	210	
Benzo(a)pyrene	1	470	—
Benzo(b)fluoranthene	1	430	—
Benzo(k)fluoranthene	1	530	—
Pesticide Compounds *(2 Samples Collected, 0 Samples Duplicated)*			
alpha-chlordane	2	99-560	
gamma-chlordane	2	84-760	
Heptachlor	1	62	
Heptachlor epoxide	1	72	

Table 4.21.3
SWMU 159
Organic Compounds Detected in Sediment

Compound Name	No. of Detections	Range of Concentrations (μg/kg)	Sediment Screening Value (μg/kg)
PCB Compounds *(2 Samples Collected, 0 Samples Duplicated)*			
No PCBs detected.			
TPH *(2 Samples Collected, 0 Samples Duplicated)*			
No TPH detected.			
Indeterminate Lubricating Oils, Light Petroleum Hydrocarbons *(2 Samples Collected, 2 Samples Duplicated)*			
Indeterminate Lubricating Oil	2	52,000-2,000,000	—

Note:
— = No reported sediment screening value.

Table 4.21.4
SWMU 159
Inorganic Elements Detected in Sediment
(2 Samples Collected, 0 Samples Duplicated)

Element	No. of Detections	Range of Concentrations (mg/kg)	Sediment Screening Value (mg/kg)
Aluminum	2	4640-32,900	—
Copper	2	22.6-29.4	28
Iron	2	29,100-34,200	—
Lead	2	47.4-89.1	21
Potassium	2	367-1660	—
Sodium	2	1,280-2,590	—
Antimony	1	2.1	2
Arsenic	2	11.5-15.5	8
Barium	2	29-62.1	—
Beryllium	2	0.22-1.1	—
Cadmium	2	0.55-1	1
Cobalt	2	2.9-6.4	—
Nickel	2	11.9-14.3	20.9
Vanadium	2	22.6-66.2	—
Zinc	2	92.4-279	68
Selenium	2	2.3-2.7	—
Mercury	2	0.07-0.15	0.1
Magnesium	2	1,440-5.050	—
Manganese	2	104-245	—
Calcium	2	11,600-15,400	—
Chromium	2	40.8-68.6	33
Silver	2	0.43-0.54	—
Cyanide	0	0	—
Thallium	0	0	—

Notes:
— = No reported sediment screening value.

Table 4.21.5
SWMU 159
Organic Compounds Detected in Surface Water

Compound Name	No. of Detections	Range of Concentrations (μg/L)	Chronic Marine Water Quality Criteria (μg/L)
Volatile Organic Compounds *(1 Sample Collected, 0 Samples Duplicated)*			
No VOCs detected.			
Semivolatile Organic Compounds *(1 Sample Collected, 0 Samples Duplicated)*			
No SVOCs detected.			
Pesticides *(1 Sample Collected, 0 Samples Duplicated)*			
No pesticides detected.			
PCBs *(1 Sample Collected, 0 Samples Duplicated)*			
No PCBs detected.			
Total Petroleum Hydrocarbons-Gasoline Range Organics *(1 Sample Collected, 0 Samples Duplicated)*			
No TPH-GRO detected.			

Table 4.21.6
SWMU 159
Inorganic Compounds Detected in Surface Water
(1 Sample Collected, 0 Samples Duplicated)

Compound Name	No. of Detections	Range of Concentrations (μg/L)	Chronic Marine Quality Criteria (μg/L)
Aluminum	1	257	—
Iron	1	24,500	—
Potassium	1	17,500	—
Sodium	1	475,000	—
Arsenic	1	2.8	36
Barium	1	30.4	—
Vanadium	1	6.5	—
Zinc	1	59.9	86
Magnesium	1	48,100	—
Manganese	1	312	—
Calcium	1	73,100	—
Cyanide[a]	0	0	—

***Notes*:**
— = No reported water quality criteria value.
[a] = Cyanide was a separate analysis.

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4.22 Zone H Grid-Based Sampling

To obtain data to be used to determine upper tolerance limits of background concentrations for select compounds and elements, soil and groundwater samples were collected at grid-based sampling locations across Zone H. The grid-based sampling strategy is discussed in Section 3 (Systematic [Grid-Based] Sampling Plan) of the *Final Zone H RFI Work Plan* (E/A&H, 1995).

4.22.1 Soil Sampling and Analysis

One hundred and fifty-four soil samples were collected from locations based on the grid-based sampling network. Ninety-six were upper-interval samples and 58 were lower-interval samples. Each sample was analyzed for the standard suite of analyses: VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. Additional volume was submitted for duplicate analysis for ten samples (nine upper-and one lower-interval samples). The duplicate samples were analyzed for the standard suite of analyses as well as for herbicides, hexavalent chromium, organophosphate pesticides, total petroleum hydrocarbons, and dioxins. Tables 4.22.1 and 4.22.2 summarize the organic and inorganic results, respectively, for soil. Appendix N contains the complete report of grid-based analytical data.

4.22.1.1 Volatile Organic Compounds in Soil

Twelve VOCs were detected in the grid-based soil samples. The most commonly detected VOCs were acetone, toluene, and methylene chloride. No VOCs were detected in the grid-based soil samples at concentrations exceeding their RBSLs. Detected concentrations of VOCs were one to seven orders of magnitude below their respective RBSLs.

4.22.1.2 Semivolatile Organic Compounds in Soil

Twenty-five SVOCs were detected in the grid-based soil samples. The most commonly detected SVOCs were bis(2-ethylhexyl)phthalate, pyrene, and fluoranthene. Benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene were detected at concentrations exceeding their respective RBSLs. All other SVOCs were one to four orders of magnitude lower than their respective RBSLs.

4.22.1.3 Pesticides and PCBs in Soil

Fifteen pesticide compounds were detected in the grid-based soil samples. The most commonly detected pesticide compounds were alpha-chlordane, gamma-chlordane, 4,4'-DDE, and 4,4'-DDT. Dieldrin, Chlordane (alpha + gamma), and kepone were the only pesticides detected at concentrations exceeding their respective RBSLs. Other pesticide compounds were detected at less than one to three orders of magnitude lower than their respective RBSLs.

Two PCB compounds (Aroclors-1254 and 1260) were detected in the grid-based soil samples. Both were detected at concentrations exceeding their RBSLs.

4.22.1.4 Other Organic Compounds in Soil

Petroleum hydrocarbons were detected in two of the 10 samples duplicated. Herbicides were detected in six of the 10 duplicate samples. Two herbicides were detected 2,4,5-TP [Silvex], and 2,4,5-T. Neither was detected at a concentration that exceeded its RBSL. No organophosphate pesticides were detected in the duplicated grid-based soil samples. Dioxin was detected in all 10 of the duplicate sample analyses. The TEQ concentration of the dioxin detections did not exceed the dioxin screening level.

4.22.1.5 Inorganic Elements in Soil

Five elements were detected at concentrations exceeding their respective RBSLs and interval-specific UTLs. Thallium, arsenic, and chromium were in both sampling intervals at concentrations exceeding RBSLs and UTLs. Mercury and manganese were detected at concentrations in the upper interval which exceeded their RBSLs and interval-specific UTLs.

4.22.2 Groundwater Sampling and Analysis

Eleven pairs of monitoring wells were installed at grid locations to provide groundwater samples from unimpacted areas of Zone H. Each pair consists of deep and shallow monitoring wells. In the first sampling round, groundwater samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. One shallow and one deep first-round sample were also tested for TPH. In the second round, analytes were chosen for each grid well based on analytical results from the first round. Second-round groundwater samples were analyzed for metals (11 shallow samples, 11 deep samples), SVOCs (seven shallow, seven deep), VOCs (three shallow, two deep), pesticides (two shallow, one deep), and herbicides (one shallow).

In the first sampling round, three of the 11 shallow samples and one of the 11 deep samples were duplicated and submitted for analysis of herbicides, hexavalent chromium, organophosphate pesticides, and dioxins in addition to the standard suite of analyses. In the second round, one shallow sample and two deep samples were duplicated and analyzed for the same parameters as the primary samples for those wells. Groundwater was sampled in accordance with procedures detailed in Section 2.4. Table 4.22.3 (organic data for shallow monitoring wells), Table 4.22.4 (organic data for deep wells), Table 4.22.5 (inorganic data for shallow wells), and Table 4.22.6 (inorganic data for deep wells) summarize analytical data for groundwater samples collected from wells at grid locations. Appendix I presents a complete report of groundwater analytical data. Groundwater sampling locations are shown on Figure 4.0.

4.22.2.1 Volatile Organic Compounds in Groundwater

Three VOCs were detected in first-round groundwater samples from shallow grid wells in Zone H, with each compound appearing in only one of the 11 wells. Carbon disulfide was detected at 7 μg/L in the sample from well NBCHGDH011. Acetone and toluene were also reported, both at low concentrations.

In the second sampling round, carbon disulfide was detected at 84 μg/L in the sample from well NBCHGDH004.

Two VOCs occurred in first-round groundwater samples collected from deep grid wells in Zone H. Benzene was detected at 2.8 μg/L in the sample from deep well NBCHGDH04D. Methylene chloride was reported at concentrations of 5 and 6 μg/L in samples from wells NBCHGDH11D and NBCHGDH01D, respectively.

Second-round samples from deep grid wells contained three VOCs. Benzene was at a concentration of 4.45 μg/L in the sample from monitoring well NBCHGDH04D. Acetone and toluene each were detected in single samples at low concentrations.

4.22.2.2 Semivolatile Organic Compounds in Groundwater

In groundwater samples collected from shallow grid wells during the first sampling round, acenaphthene and naphthalene were the only SVOCs detected. Both were reported at low concentrations.

Acenaphthene was the only SVOC found in second-round samples from shallow grid wells. It was detected in a single sample at a concentration of 3.6 μg/L.

Five SVOCs were detected in deep samples collected during the first round. Di-n-butylphthalate, 2,4-dimethylphenol, 2-methylphenol (o-cresol), and naphthalene all appeared in the sample from well NBCHGDH04D, while BEHP was reported in the sample from NBCHGDH06D.

Six SVOCs appeared in second-round samples from deep grid wells. The sample from deep well NBCHGDH06D reported a concentration of 230 μg/L of BEHP. Di-n-octylphthalate, 2,4-dimethylphenol, 2-methylphenol (o-cresol), and naphthalene were detected in the sample from NBCHGDH04D. Di-n-butylphthalate was reported at concentrations of 2.4 μg/L and 2.7 μg/L in samples from NBCHGDH09D and NBCHGDH10D.

4.22.2.3 Pesticides and PCBs in Groundwater

No pesticides were detected in any shallow groundwater samples collected from Zone H grid-based wells in either the first or second sampling rounds.

In the first sampling round, the pesticide 4,4'-DDT was detected in one sample from deep monitoring well NBCHGDH02D at a concentration of 0.06 μg/L. No pesticides were detected in second-round samples from deep wells.

PCBs were not detected in any first-round samples from grid wells, shallow or deep. Consequently, PCBs were not analyzed in samples collected in the second round.

4.22.2.4 Other Organic Compounds in Groundwater

Three duplicate first-round samples from shallow grid wells were analyzed for herbicides, organophosphate pesticides, and dioxins in addition to the standard suite of analyses. One shallow first-round sample was analyzed for herbicides. Analysis for herbicides was performed on one second-round sample from a shallow monitoring well.

Herbicides were not detected in first-round samples from shallow wells. The herbicide DCAA was reported from well NBCHGDH009 at a concentration of 86 μg/L in a sample from the second round.

Neither organophosphate pesticides nor dioxins were detected in the duplicate first-round samples from shallow grid wells. Petroleum hydrocarbons were not detected in the single shallow sample (from well NBCHGDH003) analyzed for TPH.

No herbicides, organophosphate pesticides, or dioxins were found in the deep groundwater sample from well NBCHGDH10D that was duplicated in the first sampling round, nor were petroleum hydrocarbons detected during the TPH analysis of the sample from well NBCHGDH03D. For deep wells during the second sampling round, no duplicate samples were analyzed for Appendix IX parameters, nor were any TPH samples collected.

4.22.2.5 Inorganic Chemicals in Groundwater

In first-round groundwater samples from shallow grid wells in Zone H, arsenic, manganese, and thallium were among the 15 metals detected (Table 4.22.5): Arsenic from 0.8 to 13.9 μg/L in seven of 11 samples, manganese from 19.2 to 4,570 μg/L in 10 samples, and thallium from 1.9 to 105 μg/L in three samples.

Cyanide was reported from one of 11 shallow first-round samples, at a concentration of 10 μg/L in monitoring well NBCHGDH006. Hexavalent chromium was not detected in any of the three first-round duplicate samples from shallow wells.

Arsenic and manganese were detected in second-round groundwater samples from shallow wells, along with nine other metals. Arsenic was detected in samples from two shallow wells at concentrations of 7.3 and 24.8 μg/L, with the higher value from well NBCHGDH003. Manganese appeared in 11 shallow samples, with concentrations ranging from 16.6 to 3,190 g/L. Cyanide and hexavalent chromium were not analyzed in shallow second-round samples.

Nineteen metals were detected in at least one first-round sample from deep grid wells (Table 4.22.6), including arsenic, cadmium, manganese, and thallium. Arsenic was detected in three samples at concentrations of 2.2-8.2 μg/L, cadmium in one sample at 2.6 μg/L, manganese in 10 samples, and thallium in one sample from well NBCHGDH08D at 5.6 μg/L.

Neither cyanide nor hexavalent chromium was detected in the single deep sample that was duplicated in the first round. No analysis was performed for either chemical in the second sampling round.

Analysis of second-round samples from deep grid wells in Zone H yielded detections of 14 metals, including antimony, barium, cadmium, manganese, and zinc. Antimony was found in samples from wells NBCHGDH10D and NBCHGDH11D, both at 11.5 μg/L. Barium appeared in seven deep second-round samples, with its highest reported concentration in the sample from well NBCHGDH11D at 871 μg/L. Cadmium's three highest detections were 2.0 μg/L from NBCHGDH05D, 2.4 μg/L from NBCHGDH08D, and 2.3 μg/L from NBCHGDH11D.

Manganese was detected in all 11 deep samples, ranging to 821 μg/L in well NBCHGDH11D. The single deep zinc detection was 1,180 μg/L in the sample from well NBCHGDH11D. The highest values for barium and manganese were 871 μg/L and 821 μg/L, respectively, in samples from well NBCHGDH11D.

Table 4.22.1
Zone H Grid-Based Soil Samples
Organic Compounds in Soil (in μg/kg)

Compound Name	Number of Detections (Upper Interval/Lower Interval)	Range of Concentrations for Detections (Upper Interval/Lower Interval)	Risk-Based Screening Levels
Volatile Organic Compounds *(154 Samples Collected — 96 Upper Interval Samples, 58 Lower Interval Samples, 10 Samples Duplicated)*			
Acetone	44/39	8-12,000 / 11-2,300	780,000
Bromomethane	1/2	5 / 3-4.3	11,000
2-Butanone (MEK)	2/4	14-17 / 4-100	4,700,000
Carbon disulfide	1/1	1.3 / 15	780,000
Methylene chloride	20/14	3.8-11 / 3.7-18	85,000
Tetrachloroethene	4/4	7-22 / 7-25	12,000
Tetrahydrofuran	1/1	31 / 87	Not Listed
Toluene	45/28	2.1-67.5 / 3.3-26.0	1,600,000
1,1,1-Trichloroethane	2/2	6-9 / 7-10	700,000
Trichloroethene	5/2	2-3.5 / 2.5-6	47,000
Trichlorofluoromethane	1/0	7.3 / 0	2,300,000
Xylene (total)	1/0	1.6 / 0	16,000,000
Semivolatile Organic Compounds *(154 Samples Collected — 96 Upper Interval Samples, 58 Lower Interval Samples, 10 Samples Duplicated)*			
Acenaphthene	9/2	88-6,600 / 100-170	470,000
Acenaphthylene	1/0	460 / 0	470,000
Anthracene	13/2	41.4-840 / 74-310	2,300,000
BEHP	26/1	39-680 / 400	46,000
Benzo(a)anthracene	17/3	48-1,900 / 120-640	880
Benzo(b)fluoranthene	14/1	40.6-2,840 / 270	880
Benzo(k)fluoranthene	11/0	88-2,340 / 0	8,800
Benzo(a)pyrene	16/3	81-1,400 / 140-480	88
Benzo(g,h,i)perylene	11/1	97-1,110 / 220	310,000
Butylbenzylphthalate	5/0	65.8-580 / 0	1600,000
4-Chloro-3-methylphenol	1/0	170 / 0	Not Listed

Table 4.22.1
Zone H Grid-Based Soil Samples
Organic Compounds in Soil (in μg/kg)

Compound Name	Number of Detections (Upper Interval/Lower Interval)	Range of Concentrations for Detections (Upper Interval/Lower Interval)	Risk-Based Screening Levels
Semivolatile Organic Compounds *(154 Samples Collected — 96 Upper Interval Samples, 58 Lower Interval Samples, 10 Samples Duplicated)*			
2-Chlorophenol	1/0	160 /0	39,000
Chrysene	18/3	50-1,700 / 140-580	88,000
Dibenzo(a,h)anthracene	7/0	84-456 / 0	88
Dibenzofuran	4/0	150-4,300 / 0	31,000
Di-n-butylphthalate	1/0	140 / 0	780,000
Di-n-octylphthalate	2/0	200-660	160,000
Fluoranthene	25/5	50.7-3,245 / 130-1,400	310,000
Fluorene	7/2	100-4,500 / 120-190	310,000
Indeno(1,2,3-cd)pyrene	12/1	94-1,110 / 220	880
2-Methylnaphthalene	3/0	91-4,200 / 0	310,000
Naphthalene	4/0	110-7,500 / 0	310,000
Phenanthrene	17/3	86-2,900 / 350-1,200	310,000
Phenol	1/0	160 / 0	4,700,000
Pyrene	25/4	45.8-2,940 / 120-1,100	230,000
Pesticides *(154 Samples Collected — 96 Upper Interval Samples, 54 Lower Interval Samples, 10 Samples Duplicated)*			
beta-BHC	0/1	4.2 / 0	350
Chlorobenzilate	1/0	124 / 0	2,400
alpha-Chlordane	20/5	1-330 / 2-19	470 (alpha + gamma)
gamma-Chlordane	19/6	1-260 / 3-73	
4,4'-DDE	33/15	2-270 / 2-22	1,900
4,4'-DDD	7/4	6-130 / 7-120	2,700
4,4'-DDT	30/3	2.1-180 / 5-21	1,900
Dieldrin	5/1	4-300 / 8	40

Table 4.22.1
Zone H Grid-Based Soil Samples
Organic Compounds in Soil (in μg/kg)

Compound Name	Number of Detections (Upper Interval/Lower Interval)	Range of Concentrations for Detections (Upper Interval/Lower Interval)	Risk-Based Screening Levels
Pesticides *(154 Samples Collected — 96 Upper Interval Samples, 54 Lower Interval Samples, 10 Samples Duplicated)*			
Endosulfan I	2/0	4-31 / 0	47,000
Endosulfan sulfate	1/0	9 / 0	47,000
Endrin	3/0	2.2 / 84.8	2,300
Endrin aldehyde	3/1	5-100 / 7	2,300
Heptachlor	2/1	1.3-2 / 11	140
Heptachlor epoxide	6/1	2-9 / 5	70
Kepone	1/0	151 / 0	35
Polychlorinated Biphenyls *(154 Samples Collected — 96 Upper Interval Samples, 58 Lower Interval Samples, 10 Samples Duplicated)*			
Aroclor-1254	3/0	35-240 / 0	83
Aroclor-1260	18/4	23-4,000 / 58-290	83
Petroleum Hydrocarbons *(10 Samples Duplicated — 9 Upper Interval Samples, 1 Lower Interval Samples)*			
Total Petroleum Hydrocarbons	2/0	72-220 / 0	Not Listed
Herbicides *(10 Duplicate Analyses — 9 Upper Interval Samples, 1 Lower Interval Samples)*			
2,4,5-TP (Silvex)76	3/1	7.3-9.5 / 7	63,000
2,4,5-T	2/0	8.2-9.8 / 0	78,000
Organophosphate Pesticides *(10 Duplicate Analyses — 9 Upper Interval Samples, 1 Lower Interval Samples)*			
No organophosphate pesticides detected.			
Dioxins *(10 Duplicate Analyses — 9 Upper Interval Samples, 1 Lower Interval Samples)*			
Total TEQ Values	9/1	0.79-14.25 pg/g (upper) 0.76-0.76 pg/g (lower)	1,000 pg/g

Table 4.22.2
Zone H Grid-Based Soil Samples
Inorganic Elements in Soil (in mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[c]
Aluminum[a]	96/58	96/58	1,090-32,700 798-45,300	7,900	25,310/46,180
Iron[a]	96/58	96/58	695-38,800 1,210-54,300	Not Listed	30,910/66,170
Lead	96/58	82/45	1.8-172 2.1-39.4	400	118/68.69
Nickel	96/58	86/49	0.63-91.8 0.74-78.3	160	33.38/29.90
Potassium[a]	96/58	79/49	65-2,960 60.1-2,800	Not Listed	Nutrient[e]
Silver	96/58	2/1	0.55-0.74 1.7	39	Not Valid[d]
Sodium[a]	96/58	94/56	10.2-1,660 11.3-2,110	Not Listed	Nutrient[e]
Thallium	96/58	10/9	0.07-1.1 0.36-1.9	0.63	0.63/1.3
Antimony	96/58	6/4	1.1-2.2 1.5-19.4	3.1	Not Valid[d]
Arsenic	96/58	85/54	0.64-18.4 0.78-136	0.37	14.81/35.52
Barium	96/58	85/42	3.6-72.8 2.4-59.9	550	40.33/43.80
Beryllium	96/58	86/55	0.04-1.4 0.06-1.60	0.15	1.466/1.62
Cadmium	96/58	21/6	0.12-1.4 0.14-1.2	3.9	1.05/1.10
Cobalt	96/58	73/44	0.49-7.9 0.27-12	470	5.863/14.88
Copper	96/58	81/46	0.94-126 0.53-34.5	290	27.6/31.62
Vanadium	96/58	95/58	4.1-74.8 2.7-103	55	77.38/131.6
Zinc	96/58	88/51	5-431 1.8-233	2,300	214.3/129.6
Selenium	96/58	27/22	0.14-2.6 0.36-3.9	39	2.0/2.7
Mercury	96/58	69/33	0.02-3.8 0.02-1.3	2.3	0.485/.74
Magnesium[a]	96/58	96/58	131-7,850 79.6-12,700	Not Listed	9,592/9,179
Manganese[a]	96/58	96/58	5.3-1,200 5.6-966	39	636.4/1,412
Calcium	96/58	96/58	169-333,000 346-320,000	Not Listed	Nutrient[e]
Chromium	96/58	95/58	3.4-114 2.9-95.2	39	85.65/83.86

Notes:

(a) = Elements that are not included in both SW-846 and Appendix IX methods.
(b) = Included in duplicate sample analyses only.
(c) = See Appendix J for UTL determination.
(d) = Number of nondetections prevented determination of UTLs.
(e) = Elements considered to be nutrients; therefore, UTL was not determined.

Table 4.22.3
Grid (GDH) Locations
Organic Compounds in Shallow Groundwater (μg/L)

Round 1: 11 Samples Collected, 3 Samples Duplicated
Round 2: 11 Samples Collected, 1 Sample Duplicated

Compound Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Max. Contam. Level
Volatile Organic Compounds (Round 1: 11 Samples Collected, 3 Samples Duplicated) (Round 2: 3 Samples Collected, 1 Sample Duplicated)					
Acetone	1	1	23	370	Not Listed
	2	0	--		
Carbon disulfide	1	1	7	2.1	Not Listed
	2	1	84		
Toluene	1	1	1.3	75	1000
	2	0	--		
Semivolatile Organic Compounds (Round 1: 11 Samples Collected, 3 Samples Duplicated) (Round 2: 7 Samples Collected, 1 Sample Duplicated)					
Acenaphthene	1	1	3.8	220	Not Listed
	2	1	3.6		
Naphthalene	1	1	2.6	150	Not Listed
	2	0	--		
Herbicides (Round 1: 3 Samples Duplicated) (Round 2: 1 Sample Collected)					
DCAA	1	--	No Analysis	Not Listed	Not Listed
	2	1	86		
Pesticides (Round 1: 11 Samples Collected, 3 Samples Duplicated) (Round 2: 2 Samples Collected)					
No pesticides detected.					
Polychlorinated Biphenyls (Round 1: 11 Samples Collected, 3 Samples Duplicated)					
No PCBs detected.					
Organophosphate Pesticides (Round 1: 3 Samples Duplicated)					
No organophosphate pesticides detected.					
Total Petroleum Hydrocarbons (Round 1: 1 Sample Collected)					
No TPH detected.					
Dioxin (Round 1: 3 Samples Duplicated)					
No dioxins detected.					

Note:
(a) = Only compounds with detections are listed.

Table 4.22.4
Grid (GDH) Locations
Organic Compounds in Deep Groundwater (μg/L)

Round 1: 11 Samples Collected, 1 Sample Duplicated
Round 2: 11 Samples Collected, 2 Samples Duplicated

Compound Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Levels	Max. Contam. Levels
Volatile Organic Compounds (Round 1: 11 Samples Collected, 1 Sample Duplicated) (Round 2: 2 Samples Collected, 1 Sample Duplicated)					
Acetone	1	0	--	370	Not Listed
	2	1	32		
Benzene	1	1	2.8	0.346	5
	2	1	4.45		
Methylene chloride	1	2	5-6	4.1	5
	2	0	--		
Toluene	1	0	--	75	1,000
	2	1	4.2		
Semivolatile Organic Compounds (Round 1: 11 Samples Collected, 1 Sample Duplicated) (Round 2: 7 Samples Collected, 2 Samples Duplicated)					
Di-n-butylphthalate	1	1	2.6	370	Not Listed
	2	2	2.4-2.7		
Di-n-octylphthalate	1	0	--	73	Not Listed
	2	1	5		
2,4-Dimethylphenol	1	1	15	73	Not Listed
	2	1	15		
BEHP	1	1	3.9	4.8	6
	2	1	230		
2-Methylphenol (o-cresol)	1	1	20	180	Not Listed
	2	1	8.4		
Naphthalene	1	1	17	150	Not Listed
	2	1	24		
Pesticides (Round 1: 11 Samples Collected, 1 Sample Duplicated) (Round 2: 1 Sample Collected, 0 Samples Duplicated)					
4,4-DDT	1	1	0.06	0.2	Not Listed
	2	0	--		

Table 4.22.4
Grid (GDH) Locations
Organic Compounds in Deep Groundwater (μg/L)

Round 1: 11 Samples Collected, 1 Sample Duplicated
Round 2: 11 Samples Collected, 2 Samples Duplicated

Compound Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Levels	Max. Contam. Levels
Herbicides (Round 1: 1 Sample Duplicated)					
No herbicides detected.					
Total Petroleum Hydrocarbons (Round 1: 1 Sample Collected)					
No TPH detected.					

Note:
(a) = Only compounds with detections are listed.

Table 4.22.5
Grid (GDH) Locations
Inorganic Chemicals in Shallow Groundwater (μg/L)

Round 1: 11 Samples Collected, 3 Samples Duplicated
Round 2: 11 Samples Collected, 1 Sample Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum[c]	1 2	1 2	125 162.2-491	3,700	Not Valid	Not Listed
Arsenic	1 2	7 2	0.8-13.9 7.3-24.8	0.038	27.99	50
Barium	1 2	6 4	2.9-54.5 5.2-59.4	260	323	2,000
Calcium[d]	1 2	11 10	55,500-720,000 59,000-659,000	Not Listed	Nutrient	Not Listed
Cobalt[c]	1 2	1 0	2.4 --	220	Not Valid	Not Listed
Iron	1 2	9 11	490-28,000 432.5-28,700	Not Listed	45,760	Not Listed
Lead	1 2	6 0	1.1-3.2 --	15[e]	4.7	15[e]
Magnesium	1 2	11 11	10,000- 1,090,000 12,950-978,000	Not Listed	3,866,000	Not Listed
Manganese	1 2	10 11	19.2-4,570 16.6-3,190	18	3,391	Not Listed
Nickel[c]	1 2	1 0	20.7 --	73	Not Valid	100
Potassium[d]	1 2	11 11	5,010-297,000 5,905-239,000	Not Listed	Nutrient	Not Listed
Selenium	1 2	5 1	1.1-1.8 5.0	18	3.15	50
Sodium[d]	1 2	11 10	18,700- 8,590,000 26,800- 7,330,000	Not Listed	Nutrient	Not Listed
Thallium	1 2	3 0	1.9-105 --	0.29[f]	7.66	2

Table 4.22.5
Grid (GDH) Locations
Inorganic Chemicals in Shallow Groundwater (μg/L)

Round 1: 11 Samples Collected, 3 Samples Duplicated
Round 2: 11 Samples Collected, 1 Sample Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Vanadium[c]	1	1	7.6	26	Not Valid	Not Listed
	2	0	--			
Zinc[c]	1	0	--	1,100	Not Valid	Not Listed
	2	1	6.6			
Hexavalent Chromium	1	--	Not Detected			
	2	--	No Analysis			
Cyanide	1	1	10	73		
	2	--	No Analysis			

Notes:
(a) = Only elements with detections are listed. Hexavalent chromium and cyanide are separate analyses.
(b) = See Appendix J for UTL determinations.
(c) = High percentage of nondetects prevented determination of UTL.
(d) = Element considered to be a nutrient; therefore, UTL was not determined.
(e) = Based on treatment technique AL.
(f) = Thallium carbonate used as surrogate.

Table 4.22.6
Grid (GDH) Locations
Inorganic Chemicals in Deep Groundwater (μg/L)

Round 1: 11 Samples Collected, 1 Sample Duplicated
Round 2: 11 Samples Collected, 2 Samples Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Aluminum	1	3	16.1-207	3,700	723	Not Listed
	2	1	745			
Antimony[c]	1	0	--	1.5	Not Valid	6
	2	2	11.5-11.5			
Arsenic	1	3	2.2-8.2	0.038	14.98	50
	2	0	--			
Barium	1	5	30.1-95.7	260	236.9	2,000
	2	7	40.8-871			
Cadmium[c]	1	1	2.6	1.8	Not Valid	5
	2	4	1.5-2.4			
Calcium[d]	1	11	92,900-213,000	Not Listed	Nutrient	Not Listed
	2	11	7,650-228,000			
Chromium[c]	1	1	7.4	18	Not Valid	100
	2	2	2.7-4.1			
Cobalt	1	2	2.6-3.0	220	3.17	Not Listed
	2	0	--			
Iron	1	9	528-6,470	Not Listed	8,787	Not Listed
	2	9	356-6,280			
Lead	1	4	2.4-3.0	15[e]	4.26	15[e]
	2	1	1.9			
Magnesium	1	11	629,000-943,000	Not Listed	1,114,000	Not Listed
	2	11	1,290-1,130,000			
Manganese	1	10	12.2-555	18	776.2	Not Listed
	2	11	3.2-821			
Mercury[c]	1	1	0.1	1.1	Not Valid	2
	2	0	--			
Nickel[c]	1	1	12.8	73	Not Valid	100
	2	0	--			

Table 4.22.6
Grid (GDH) Locations
Inorganic Chemicals in Deep Groundwater (μg/L)

Round 1: 11 Samples Collected, 1 Sample Duplicated
Round 2: 11 Samples Collected, 2 Samples Duplicated

Chemical Name[a]	Sampling Round	Number of Detections	Range of Concentrations for Detections	Risk-Based Screening Level	Upper Tolerance Limit of Background[b]	Max. Contam. Level
Potassium[d]	1 2	11 11	143,000-236,000 9,050-260,000	Not Listed	Nutrient	Not Listed
Selenium	1 2	4 0	0.9-1.4 --	18	2.1	50
Sodium[d]	1 2	11 11	5,040,000-6,810,000 1,360,000-7,640,000	Not Listed	Nutrient	Not Listed
Thallium[c]	1 2	1 0	5.6 --	0.29[f]	Not Valid	2
Vanadium	1 2	3 5	3.7-6.8 4.1-9.0	26	9.29	Not Listed
Zinc[c]	1 2	1 1	61.9 1,180	1,100	Not Valid	Not Listed
Hexavalent Chromium	1 2	-- --	Not Detected No Analysis			
Cyanide	1 2	-- --	Not Detected No Analysis			

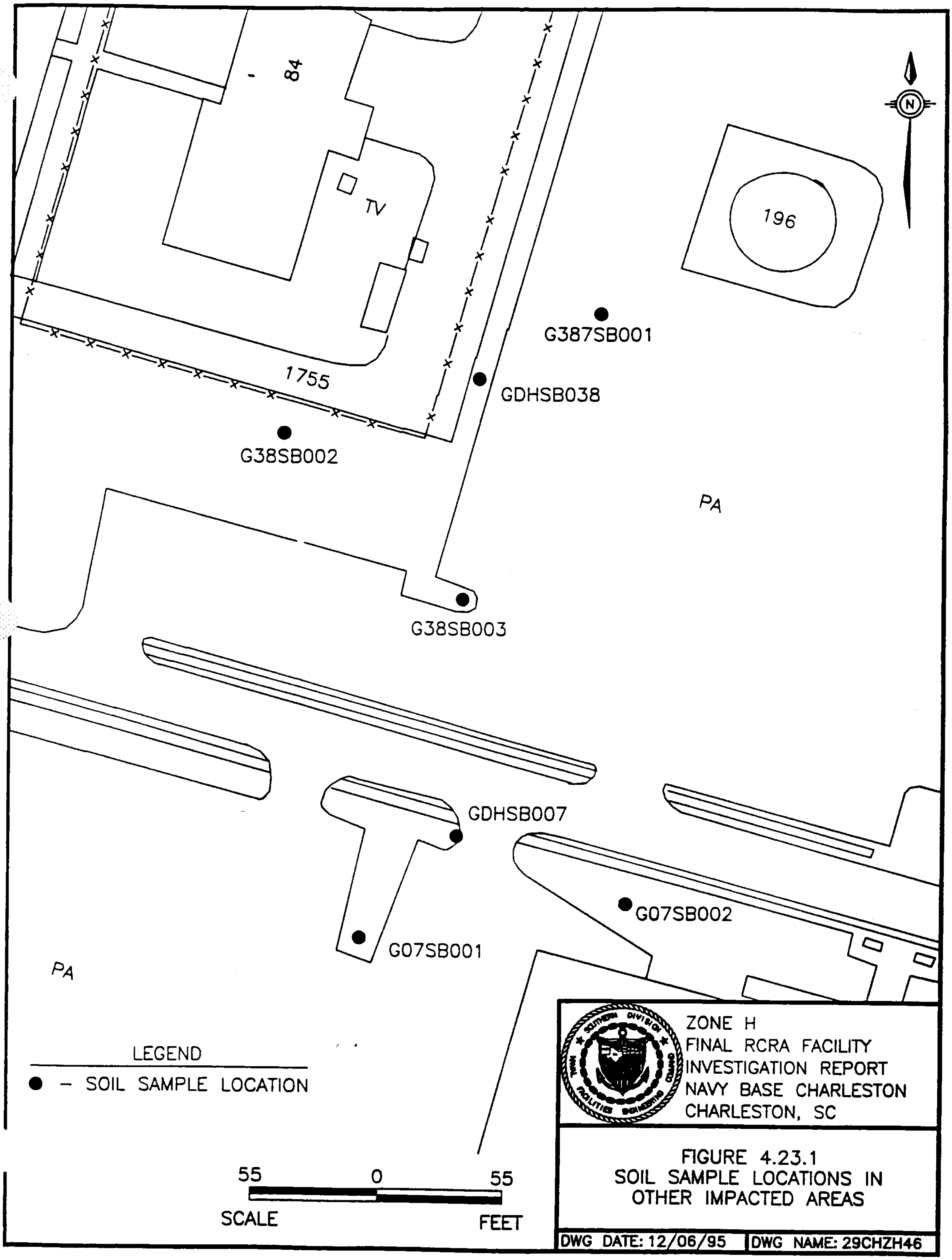
Notes:
(a) = Only elements with detections are listed. Hexavalent chromium and cyanide are separate analyses.
(b) = See Appendix J for UTL determinations.
(c) = High percentage of nondetects prevented determination of UTL.
(d) = Element considered to be a nutrient; therefore, UTL was not determined.
(e) = Based on treatment technique AL.
(f) = Thallium carbonate used as surrogate.

4.23 Other Impacted Areas

Other Impacted Areas (OIAs) represent two areas where the grid-based soil samples contained significantly high concentrations of various compounds. One of these areas was the area where GDHSB007 and GDHSB038 samples were collected. This area is referred to as OIA G07 and G38, based on the identifications of the grid-based soil samples. The second area was in the vicinity of sample location GDHSB080. This area is referred to as OIA G80.

Two of the upper-interval grid-based soil samples contained concentrations of Aroclor-1260 that were significantly higher than the RBSL of 83 μg/kg for that PCB compound (Figure 4.23.1). Soil samples GDHSB00701 and GDHSB03801 contained 2600 and 4000 μg/kg of Aroclor-1260, respectively. The GDHSB038 sample from the second interval also contained Aroclor-1260 at 290 μg/kg. Analytical results for supplemental samples collected near these grid-based sample locations identified Aroclor-1260 in the lower-interval sample at location G38SB001 (160 μg/kg), the upper-interval sample at location G38SB003 (1,100 μg/kg), and the upper interval sample at location G07SB001 (970 μg/kg). Table 4.23.1 summarizes the PCB data for the two grid locations and the supplemental sample locations. Appendix N contains a complete report of analytical data for soil samples collected in the vicinity of sample locations GDHSB007 and GDHSB038.

During the construction of monitoring well NBCHGDH04D (Figure 4.23.2), a piece of treated timber (possibly old piling) was removed from the borehole at approximately 7 feet below ground surface. Due to the apparent contamination of the soil and other accompanying matter, a soil sample (GDHSW04D07) was collected and submitted for the standard suite of analyses. The results of this soil sample analysis reflected significant quantities of SVOCs. Two grid-based soil samples (one upper-interval and one lower-interval) were collected from the GDHSB080 sample location (at the monitoring well location) after the grid-based wells were installed and before the analytical results for the soil sample collected during well construction were received. Upon receipt of the analytical results for the soil sample from the monitoring well, eight supplemental soil samples (four upper-interval and four lower-interval) were collected from locations G80SB001, G80SB002, G80SB003, and G80SB004. The analytical results for the grid-based soil samples collected at GDHSB080 and the supplemental soil sample locations did not reflect the degree of contamination detected in the monitoring well soil sample. Analytical results for the groundwater samples collected from the two grid-based monitoring wells also did not reflect the degree of contamination detected in the monitoring well soil sample. Table 4.23.2 lists the results of sample analysis for samples collected near monitoring well NBCHGDH04D. Appendix N contains a complete report of analytical data for soil samples collected in the vicinity of monitoring well NBCHGDH04D.



ZONE H
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INVESTIGATION REPORT
NAVY BASE CHARLESTON
CHARLESTON, SC

FIGURE 4.23.1
SOIL SAMPLE LOCATIONS IN
OTHER IMPACTED AREAS

DWG DATE: 12/06/95 | DWG NAME: 29CHZH46

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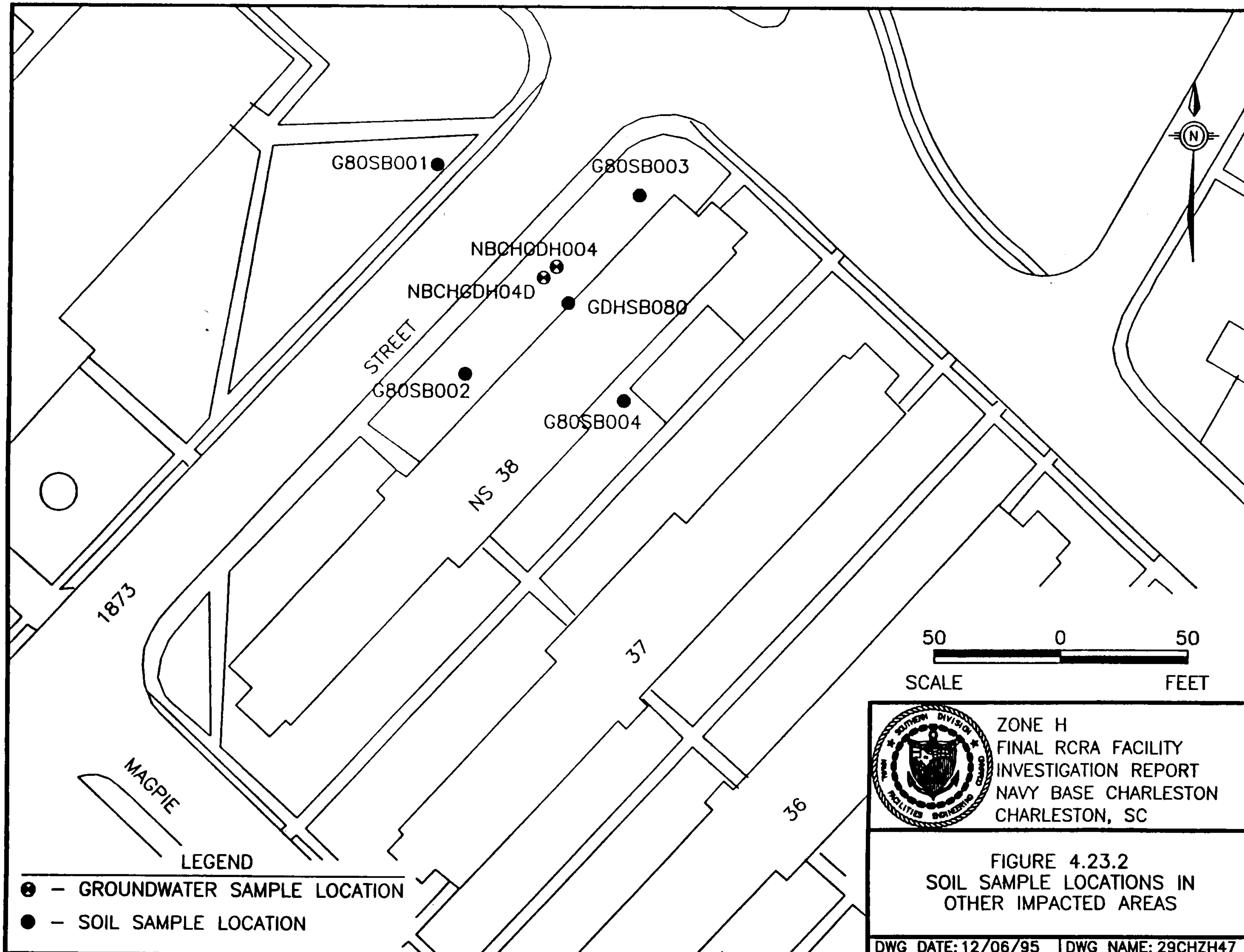

ZONE H
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INVESTIGATION REPORT
NAVY BASE CHARLESTON
CHARLESTON, SC

FIGURE 4.23.2
SOIL SAMPLE LOCATIONS IN
OTHER IMPACTED AREAS

DWG DATE: 12/06/95 | DWG NAME: 29CHZH47

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Table 4.23.1
Area of GDHSB007 and GDHSB038 Soil Sample Locations
PCBs in Soil (in μg/kg)[a]

Compound	Number of Samples Analyzed (1st interval/2nd interval)	Number of Detections (1st interval/2nd interval)	Range of Concentrations (1st interval/2nd interval)	Risk-Based Screening Levels
Aroclor- 1260	7/7	4/2	970/4,000/ 160-290	83

Note:
[a] = Includes data for samples collected at locations GDHSB007 and GDHSB038.

Table 4.23.2
Area of NBCHGDH04D
SVOCs in Soil (μg/kg) and Groundwater (μg/L)

Compound	No. of Analyses (1st interval/2nd interval)	No. of Detections (1st interval/2nd interval)	Range of Concentrations	Risk-Based Screening Levels
The following are SVOC data from soil samples collected in the immediate vicinity of the monitoring well where the contaminated timber sample was collected.				
Phenanthrene	5/5	3/1	140-430/460	310,000
Anthracene	5/5	2/1	90-94/74	2,300,000
Fluoranthene	5/5	3/1	210-510/490	310,000
Pyrene	5/5	3/1	160-410/420	230,000
Benzo(a)anthracene	5/5	3/1	86-220/190	880
Chrysene	5/5	3/1	85-230/200	88,000
bis(2-ethylhexyl)phthalate	5/5	2/0	39-110/0	46,000
Benzo(b)fluoranthene	5/5	3/1	160-300/270	880
Benzo(k)fluoranthene	5/5	2/	110-140/0	8,800
Benzo(a)pyrene	5/5	2/1	140-200/180	88
Indeno(1,2,3-cd)pyrene	5/5	1/0	98/0	880
Benzo(g,h,i)perylene	5/5	1/0	97/0	310,000

Table 4.23.2
Area of NBCHGDH04D
SVOCs in Soil (μg/kg) and Groundwater (μg/L)

Compound	No. of Analyses (1st interval/2nd interval)	No. of Detections (1st interval/2nd interval)	Range of Concentrations	Risk-Based Screening Levels
The following reflect SVOCs present in the shallow groundwater sample collected at NBCHGDH004.				
2-Methylphenol	1	1	20	180
2,4-Dimethylphenol	1	1	15	73
The following reflect SVOCs detected in the soil sample collected from 7 feet below ground surface while drilling NBCHGDH04D.				
Acenaphthene	1	1	500,000	470,000
Dibenzofuran	1	1	390,000	31,000
Fluorene	1	1	490,000	310,000
Phenanthrene	1	1	630,000	310,000
Anthracene	1	1	190,000	2,300,000
Fluoranthene	1	1	620,000	310,000
Pyrene	1	1	430,000	230,000
Naphthalene	1	1	710,000	310,000
Benzo(a)anthracene	1	1	140,000	880
Chrysene	1	1	110,000	88,000
2-Methylnaphthalene	1	1	430,000	310,000
Benzo(b)fluoranthene	1	1	39,000	880
Benzo(k)fluroanthene	1	1	42,000	8,800
Benzo(a)pyrene	1	1	34,000	88
Acenaphthylene	1	1	17,000	470,000